The transmission of monetary policy in the Lao People's Democratic Republic

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Vimaly Savannarideth

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Dissertation

Summary

Vimaly Savannarideth

Philipps University Marburg, Department of Business and Economics,

Universitaetsstraße 25, D-35037 Marburg. Email: Savannar@students.uni-marburg.de

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1. General motivation for the thesis

In 1982, when it was still under a centrally planned economy, the Lao People's Democratic Republic (Laos) gross domestic product was only 11 billion kip. In 1986 the central government declared that it was to adopt a market economy. The transition toward a market economy was accompanied by an expansion of the domestic financial market as well as real sector with a boost from foreign investment. Gross domestic product grew from 11 billion Kip in 1982 to roughly 73,000 billion Kip in 2012. According to the World Bank 2011 report, foreign direct investment in the Lao PDR had increased from 100 million USD to 800 million USD between 2003 and 2010. Hydropower and mining accounted for approximately 80 percent of the inflow. With the expansion of the economy, the financial market has also grown. This has also been accompanied by a greater degree of openness to trade and capital movements. Given such development, the macroeconomic environment, namely output and inflation, has become more volatile. Stabilizing volatile deviations from the long-term growth path can be considered advisable and requires suitable macroeconomic instruments.

Generally, monetary policy and fiscal policy are the main macroeconomic instruments available to a government. Laos is a developing country with relatively small share of government expenditure in terms of GDP. In the fiscal year 2011/12, government expenditure was approximately 25 percent of GDP. Limitations on the government's ability to impact the economy is not least from an inefficiently organized tax system. Taxation amounted to less than 15 percent of GDP according to the Bank of the Lao PDR Annual Report of 2012. Given this situation, fiscal policy as an instrument for stabilizing the economy, for example, the business cycle, is very limited. The government could increase public sector borrowing. However, the government is likely to be constrained in increasing public sector debt as its current external debt to GDP ratio is already close to 33 percent for the year 2012. Increasing external debt beyond this level would generally considered to be unadvisable. Internal debt could possibly be increased, but there would need to be a radical change in the way the government raises domestic debt. Consequently, monetary policy becomes the next instrument available to authorities that could be used as a stablising tool. In Laos, monetary policy is managed by the Bank of the Lao PDR (BoL) under the approval and assignment of the Government.

The success of stabilization through monetary policy depends on the effectiveness of the transmission of monetary instruments. In order to successfully use monetary instruments to stabilize macroeconomic volatility, a sound understanding of the transmission mechanism is required. However, there is little literature on monetary policy for Laos. The motivation of this study is to address this gap and to establish a better understanding of the transmission of monetary policy and its effectiveness in Laos. Many questions can be investigated with

regard to the monetary transmission mechanism but five topics were chosen for the study, which were empirically estimated, tested and analyzed one by one. As listed below, each topic aimed to answer a certain question with respect to monetary policy and its effectiveness.

(1) To evaluate the question of whether the BoL is likely to be successful in achieving output level stabilization.
(2) To evaluate the question of whether the BoL is likely to be successful in controlling inflation through the management of money supply.
(3) To evaluate the question of whether the BoL is likely to be successful in achieving the desired impact on real economy and inflation through the interest rate channel.
(4) To investigate the main determinants of inflation and whether monetary policy through the management of money supply is a potential instrument.
(5) To investigate whether the monetary model of exchange rate can help explain certain fundamental forces that drive the exchange rate (Kip per USD) movement.

2. Investigated topics and their importance to the monetary transmission mechanism in Laos

To achieve social and economic development, the government of Laos puts forward two important macroeconomic targets: i) an annual output growth of 8 percent, and ii) inflation rate to be under two digits. Apart from many other structural reforms, fiscal policy and monetary policy are the two policies controlled by the government, which are likely to have an effect on the output level and inflation stability. As discussed earlier, the limitations of the government budget may place monetary policy as the main actor for output stimulation as well as inflation stabilisation. Therefore, it is important for the government of Laos and the central bank authority to know if by conducting monetary policy these two-targeted objectives are likely to be realized. This brings us to the first two topics and they are: i) money-output Granger causality, and ii) the demand for money.

Given the discussion in economic theory as well as the experience from other countries, it is not obvious that money will affect the economy in a predictable and economically significant way. Neither is it obvious that attempting to use monetary policy for output stabilization will be successful. Therefore, the first topic studies the effects that changes in money have on the real economy. Arguably, a predictable and systematic Granger-causal relationship between money and output is a precondition for using monetary policy for business cycle stabilization. The results of the analysis will help evaluate the question of whether the BoL is likely to be successful in achieving output level stabilization. The empirical estimations are carried out using a distributed lag model. The findings, based on estimation in log-levels alone, suggest that money Granger-causes output in both bivariate and multivariate models. *This supports*

the proposition that the monetary authority in Laos could successfully affect the business cycle through the conduct of monetary policy.

In the second topic, the study of the money demand function aims to investigate the stability of the demand function in the long-run. The investigation is important for the conduct of monetary policy as it is related to inflation stabilisation. For the central bank to successfully control inflation via the adjustment of money supply, the existence of a stable demand function is a precondition. Stability of the demand for money function means that money supply, price, and income are closely related, and therefore, it would be easier for the central bank to control inflation via the adjustment of money supply. By adopting the Johansen cointegration test, it is found that there exists a long-run relationship between real narrow (broad) money, real output and interest rate. The components that drive the long-run relationship are significant and all signs are economically intuitive. Out-of-sample forecasts also provide support that the demand functions are stable for both narrow and broad money. The out-of-sample forecasts lie within the confidence intervals with only one exception for narrow money and two for broad money. *This finding of a stable money demand function supports the proposition that the BoL could potentially control the money supply to stabilize inflation*.

Typically, the management of money supply is executed through the use of monetary instruments. In the case of Laos, there are several instruments that the BoL relies on to manage the money supply namely: interest rate policy, issuance of bonds and the reserve requirement ratio. In many developed countries, where the financial markets are well integrated, interest rate policy has proved to be an effective intermediate policy target to achieve the desired impact on the real economy and inflation. A strong linkage between the monetary policy instrument and its objective can be shown by a complete pass-through from the change in the policy interest rate to the change in the short-term market rates and then subsequently to retail deposits and lending rates. Similarly, Laos also uses interest rate policy in the expectation of affecting the real economy and inflation. The third topic is dedicated to investigating the effectiveness of the interest rate pass-through from the policy interest rate to banks' retail rates. In other words, the analysis seeks to understand how banks adjust their interest rates in terms of amount and how quickly to a change in the policy rate. If the response is immediate and strong, it will justify the use of interest rate policy as an intermediate target and implies that monetary policy through the interest rate channel is a potential stabilizing instrument. Empirical results from Cholesky-impulse response functions suggest that following a one standard deviation shock in the change of Kip policy rate, both deposit and lending rates in Kip increase immediately by 0.1 and 0.2 percentage point respectively. After the first month, the responses drop back to zero. This implies that retail

interest rates in Kip do respond to a change in the policy rate but the responses are very small. *It conveys that the use of interest rate channel to achieve a desired real output and inflation target may not be an appropriate channel at this time.*

The fourth topic of interest is inflation dynamics. This seeks to examine the determinants of inflation in Laos. By better understanding what drives inflation in a country, the government authorities and the central bank can make informed decisions using the appropriate policy instruments to withstand negative impact from shocks that can drive inflation. In particular, it is important for the central bank to know for example, if inflation can be stabilized through the management of money supply. By adopting the Johansen cointegration test, the results suggest that there exists a long-run equilibrium for the included variables: log of CPI, log of real GDP, log of money supply, and log of the exchange rate. In equilibrium, it is found that real GDP, money supply and the exchange rate positively influence the price level, taking coefficients of 0.67, 0.15, and 0.65 respectively. This can be interpreted as: if real GDP increases by 1 percent, the price level would increase by 0.67 percent. Similarly, an increase of 1 percent in the exchange rate (a depreciation of the Kip) would increase the price level by 0.65 percent. For the money variable, an increase of 1 percent will increase the price level by 0.15 percent. In the short-run, it is found that the lags of: inflation, real GDP growth, money growth, and exchange rate growth are significant in explaining current inflation with net total effect coefficients of 1.01, -0.66, 0.43 and -0.46 respectively. Most signs are economically intuitive except for those of the growth of real GPD and the growth of exchange rate. With respect to the monetary variable, money supply growth has a stronger positive influence on inflation, with a net total effect of 0.43 in the short-run as compared to the long-run. *This finding supports the proposition that money supply is an important determinant of inflation in both the long and the short-run, and thus, through the management of money supply, the central bank can potentially stabilize inflation.*

The effect of the 1997 Asian financial crisis resulted in Laos having to abandon its fixed exchange rate regime. Since the exchange rate is not fixed anymore, it is important to understand what drives the exchange rate and whether there are certain fundamental forces that could explain the path of the exchange rate in Laos. The fifth analysis investigates whether the monetary approach to exchange rate can explain the fundamental forces of the exchange rate in Laos. The cointegration test is adopted to find the long-run equilibrium between exchange rate and changes in: money supply, real output and interest rate. According to the trace test, three cointegrating vectors are found, but appear to be unstable. The maximum eigenvalue test, on the one hand suggests that there is one cointegrating vector and it is stable. The long-run relation standardized with respect to exchange rate can be represented as $s_t = -0.00(m_t - m_t^*) - 1.17(y_t - y_t^*) - 0.04(i - i^*)$. It is found that the long-run

elasticity of the exchange rate with respect to the money supply differential is insignificant and exhibits the wrong sign. This is supported by the restriction test, which shows that at the 5 percent significance level we can accept that money supply differential is not significantly different from zero. On the other hand, the elasticity of the exchange rate with respect to real output differential is roughly 1 and it is significant. In other words, an increase in the real output differential by 1 percent would lead to an appreciation of the exchange rate by 1.17 percent as well. Lastly, the long-run coefficient of the interest rate differential is found to be significant and we can accept that at a 5 percent significance level, it is significantly different from zero. However, given that its coefficient is very small or close to zero, its impact on the exchange rate in the long-run is expected to be minimal. In conclusion, even though a stable cointegrating vector is found, not all of its estimated parameters are consistent with the monetary model. *Thus the results suggest that there is no strong evidence that the monetary model is useful in explaining the exchange rate between Lao Kip and U.S. dollar.*

3. Conclusion

The empirical results add to the literature on monetary policy in Laos with five important findings, which are: i) based on log-levels estimation, we find that money Granger-causes output, which lends support to the proposition that the BoL is likely to be successful in stabilizing the business cycle; ii) the investigation of the money demand function provides strong evidence that the demand function in Laos is stable which implies that the BoL is likely to be successful in controlling inflation by managing the money supply; iii) the results of the impulse response analysis find that the responses of retail interest rates to a change in the policy rate are very small, which suggest that the likelihood of the BoL using the interest rate channel to achieve the desired impact on real economy and inflation is limited at this time; iv) the investigation of inflation determinants suggests that real GDP, money supply and the exchange rate are important factors in explaining the price level in the long-run and in particular, the money variable is significant in both the long and the short-run, this supports the proposition that the BoL is likely to be successful in controlling inflation through the management of money supply; and lastly, v) the analysis using a monetary model of the exchange rate does not appear to be very useful in explaining the fundamental forces that drive the exchange rate between the Lao Kip and U.S. dollar.

Based on some of the findings, it is encouraging to know that through monetary policy, the central bank, if it chooses to, may be successful in stabilizing the business cycle and controlling inflation. This would support the government's objective of achieving a target output growth of 8 percent and inflation to be under 2 digits. This further emphasizes the importance of monetary policy in the management of Laos' economic environment.

Section 2

Money–output Granger causality revisited: an empirical analysis of Lao PDR

Money–output Granger causality revisited: an empirical analysis of Lao PDR

Vimaly Savannarideth

Philipps University Marburg, Department of Business and Economics,
Universitaetsstraße 25, D-35037 Marburg, Email: Savannar@students.uni-marburg.de

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Abstract. This paper is an empirical investigation of money-output Granger causality in Lao PDR. Estimation in levels suggests that money Granger-causes output in both bivariate and multivariate models, whereas estimation in first differences suggests money does not Granger-cause output. When a deterministic time trend is added to the models in levels, the significant influence of money on output disappears. Little evidence is found that the business cycle has a significant impact on money and output causality.

JEL Classification: E52; E23

Keywords: money-output causality.

I. Introduction

The People's Democratic Republic of Lao (Laos) started moving towards a market economy in the mid-1980s. Since then, some progress has been made in developing a market economy. The transition towards a market economy has been accompanied by an expansion of domestic financial markets, as well as an increase in the importance of external and internal shocks. This likely reflects the greater degree of openness to trade and capital movements Laos has experienced over the last decade. For instance, the World Bank (2011) reported that between 2003 and 2010, foreign investment increased from US$110 million to almost US$800 million, with hydropower and mining accounting for approximately 80 percent of the inflow.

As a result of these developments, business cycle movements have become much more volatile. Stabilising these business cycle deviations from the targeted long-term growth path can be considered advisable and requires suitable macroeconomic instruments. Generally, monetary policy and fiscal policy are the main macroeconomic instruments potentially available to a government. Laos is a small developing country. Government expenditure in financial year 2010/11 was 24 percent of GDP (Bank of Lao PDR Annual Report 2011), relatively low when compared with most developed economies. The Government's ability to influence the economy through its fiscal policy is constrained not the least from an inefficient taxation system. Taxes amount to less than 15 percent of GDP (*op. cit.*). Given this constraint, the usefulness of fiscal policy as an instrument for stabilizing the business cycle is limited unless the government is willing to amass a considerable amount of public debt or broaden the tax base. In light of its current external debt to GDP ratio of close to 39 percent, increasing debt, either internal or external, is likely to be inadvisable. The second potential macroeconomic stabilization instrument, monetary policy, is managed by the Bank of Lao PDR (BoL) but under the approval and assignment of the Government. Given the constraints on fiscal policy, monetary policy may have a role to play in ameliorating the business cycle.

The BoL believes that by changing the money supply it can affect the economy's output. An example of how the BoL tries to affect output using monetary policy can be seen in 2007 at the onset of the US subprime mortgage crisis. At that time, concerns were raised regarding Laos' GDP growth rate. Therefore, the BoL decided to conduct an expansionary monetary policy. The interest rate for Kip denominated short-term BoL loans was cut from 20 percent to 12 percent per annum. Annual GDP growth was maintained as expected at about 8 percent. It is not clear whether this growth rate was achieved as a result of the BoL's easing of monetary policy.

In certain economic theories as well as in the experience of other countries, it is not obvious that money will affect the economy in a predictable and economically significant way. It is therefore unclear that attempts to use monetary policy for output stabilization will be successful. Two important macroeconomic schools of thought have very different perspectives with respect to the question of whether money causes changes in output. On the one hand, the New-Classical

macroeconomists do not believe that money causes output, as they argue that business cycles are due to technological and consumer preference shocks. On the other hand, the New-Keynesian macroeconomists assume that due to price or wage rigidities, an increase in the nominal money supply leads to an increase in real money balances and, via the liquidity effect, to lower interest rates. Through this interest rate channel of monetary policy, a hike in money causes an upward movement in GDP and vice versa. Other transmission channels, for example through the exchange rate, credit provision, or cost of working capital, may complement or hinder such an impact of monetary policy on the economy.

Most empirical studies investigating money-output Granger causality concentrate on large and industrialized countries such as that of the United States (U.S.), United Kingdom (U.K.), Canada, Japan and the European Union (E.U.). There have been few studies of smaller and less industrialised countries. To our knowledge, there has been no empirical study that looked at the case of Laos.

The purpose of this paper is to study the effects that changes in money have on the real economy. Arguably, a predictable and systematic Granger-causal relationship between money and output is a precondition for using monetary policy for business cycle stabilization. Thus, the results of our analysis will help answer the question that the BoL is likely to be successful in achieving its stated objective. Our study is divided into five sections. Section II contains a review of stylized facts on Granger causality tests while Section III offers an explanation of the econometric procedures used in the analysis and the data sources. Section IV provides results of statistical hypotheses testing and we conclude with Section V.

II. Reviewing some stylized facts of money-output Granger causality tests

Identifying causal relationships in macroeconomic variables is difficult. In the absence of natural experiments, researchers tend to rely on the concept of Granger causality. Granger (1969) investigated the causal relationship between two related time-series variables. Granger suggested that it is possible to identify causal effects between these variables if past values of one variable can help explain current values of the other. Note that Granger causality is not identical to common notions of causality as discussed in the philosophy of science. In this section we will review some stylized facts of money-income Granger causality tests, which will form the hypotheses for the next section.

Sims (1972) was the first to apply Granger causality to the money-income causality question. Based on his study, it is possible to construct a hypothesis to test whether money Granger-causes output in a model with only two variables. His findings show that causality is unidirectional from money to income when applied to post-war US data, whereas the reverse hypothesis was rejected.

In a later study, by adopting a vector autoregression (VAR) Sims (1980) discovered that when other variables are included in the model, the role of money as a Granger-cause of income is severely reduced. From this finding, we can formulate a hypothesis to test whether the significance level of the effect of money on output will be lower if other variables are included in the model.

King and Plosser (1984) demonstrated that broad money as compared to narrow money should have more explanatory power for real activity because of reverse causality, with the money supply reacting to an increase in output. Their study showed that narrow money has weaker effect on real activity. Based on this study, we can form a testable hypothesis that the use of broad money is more likely to support Granger causality from money to output than narrow money.

Eichenbaum and Singleton (1986) argued that monetary factors do not play an important role in explaining output when the tests were performed using log-differences of the variables instead of log-levels with a time trend. To further investigate doubts about the role of money, Christiano and Ljungqvist (1988) carried out bivariate Granger causality tests with money and output data measured in (i) log-levels, and (ii) log-differences. They found that in the case of (i), there is evidence of Granger causality, whereas in the case of (ii) there is not. This suggests that the causal relationship between money and output is not robust with regards to changes in the specification of the model. Stock and Watson (1989) reported further evidence that money has significant explanatory power for industrial production both in bivariate and multivariate models. Their results also emphasize the importance of taking into account stochastic and deterministic trends in the data. They showed that money growth itself does not Granger-cause growth in output, but the deviation of the money growth from a linear time trend does. Kroland and Ohanian (1989) studied the impact of trends on money-output causality in five industrialized countries: the U.S., the U.K., Japan, Canada, and the Federal Republic of Germany (Germany). They did not find any evidence of Stock and Watson's (1989) finding for the U.S. that can be generalized to other countries. Hafer and Kutan (1997) estimated two VAR systems. One used log-levels with a deterministic time trend and the other log-differenced variables without a time trend. They found statistical evidence of a significant influence from money on real output in the log-level system but not in the log-difference system. This supports Christiano and Ljungqvist's (1988) findings. From these studies we can formulate a testable hypothesis that evidence for Granger causality can be found more easily when specifying the variables in log-levels with a deterministic time trend model instead of yields log-differences.

Thoma (1994) suggested that the different results in the literature on money-output Granger causality could be conditional on the direction of money growth, i.e., whether the rate of money growth is increasing or decreasing. For example, an acceleration of a positive money growth rate may have a different impact on output than a deceleration. Based on his proposal, we can form a

hypothesis that tests whether allowing for asymmetric effects of money on output growth and including the business cycle greatly influences results and strengthens the causal effect of money.

Investigating the robustness of the above stylized facts, Hayo (1999) provides money-output Granger causality analyses for E.U. countries as well as for Canada, the U.S. and Japan. He showed that it is very difficult to derive general conclusions about money and output causality, as the specification of the underlying model as well as the specific country and time period under investigation matter. Despite the fact that there is a large literature on the issue of money-output Granger causality, the question is still open. What the literature review suggests is that it is not possible to make any generalization across different countries or regions.

Of particular relevance to the Asian region are studies by Le and Pfau (2009) and Ahmed and Rao (2006). The former found evidence that monetary policy can affect output in Vietnam whereas the latter came to the opposite result in the case of Bangladesh, India and Pakistan. There are no studies on Laos, our country of interest. Thus, the contribution of this paper lies in the application of money-output Granger causality tests to Laos. The next section, presents the main hypothesis that we wish to investigate.

III. Econometric procedure and data source

To test whether money Granger-causes output in Laos, we propose to test five hypotheses derived by Hayo (1999) based on the extant literature:

H1: Money Granger-causes output in a two variable model.

H2: In a multivariate model, the inclusion of other variables will reduce the statistical significance of the effects of money on output.

H3: It is more likely to find Granger causality when employing broad money than narrow money.

H4: Evidence for Granger causality can be found more easily when specifying the variables in log-levels with a deterministic time trend model instead of yields log-differences.

H5: Allowing for asymmetric effects of money on output growth and including the business cycle greatly influences results and strengthens the causal effect of money.

The tests of these hypotheses in Hayo (1999) on developed countries suggest that there is no clear conclusion regarding the causality between money and output. The use of log-levels as compared to log-differences does not create bias in favour of finding Granger causality effects of money on output. Including more variables into the models does not necessarily reduce the impact of money lags. However, allowing for asymmetries raises the likelihood of discovering significant causality effects.

Conducting these tests for Laos, a distributed lag model, excluding the contemporaneous value of the variable tested as a causal influence, is adopted. In the bivariate case, we constructed a model where output is a function of its own lags and the lags of the money variable. The null hypothesis implies testing whether the coefficients of the lags of money are jointly equal to zero or not. If the hypothesis is rejected then there is evidence that money causes output.

The multivariate model is an extension of the bivariate model where in addition we include the consumer price index and interest rate, one by one. By doing so, we hope to capture the effects of other important macroeconomic variables that could have an effect on output in the model.

The *hypotheses* are tested in log-levels and log-differences of the variables. The following variables with a quarterly observation periodicity were used in our study:

(1) Real GDP
(2) Narrow Money
(3) Broad Money
(4) Interest Rate
(5) Consumer Price Index

The data starts from 1993 to 2010, and translates to 72 observations. The data used is retrieved from Allthatstats.com. The original data source for Allthatstats.com's data was the International Monetary Fund (IMF). The consistency of the database across the five variables exists only from 1993 onward. All variables are log values except the interest rate. The following are explanations of each of the variables we use in this study.

(1) Real GDP

Only annual GDP is available for Laos. The quarterly real GDP employed in this study has been interpolated using an estimation model based on the theory of best linear unbiased estimation in Chow & Lin (1971). We considered various possible variables, which could be good contemporaneous estimators for GDP. We chose to use trade data, imports and exports, due to data availability. Using the annual GDP data, we regress:

Model 1: $GDP = \alpha + \beta Import + \varepsilon$

Model 2: $GDP = \alpha + \beta Export + \varepsilon$

Model 3: $GDP = \alpha + \beta 1 Export + \beta 2 Import + \varepsilon$

Based on the results of these models, we found statistical significance for imports and exports as contemporaneous predictors of GDP. However when both imports and exports are included in a model, only imports were significant. This was consistent with imports having lower values on the information criteria. As a result, imports were preferred over exports.

Using coefficients from Model 1, we constructed a model to estimate quarterly GDP based on coefficients derived from the previous step.

Model 4: GDP* = α* + β* Import

We compared the estimated annual GDP data with the actual GDP data, took the difference and divided by 4. This difference was added to each estimated quarterly GDP value so that when summing over each year, the annual estimated GDP equalled actual GDP. The interpolated quarterly GDP was tested for seasonality but seasonality was not found.

Finally, the estimated quarterly GDP data was transformed to real quarterly GDP data by dividing it by the GDP deflator (dfl) or consumer price index (CPI). Since the deflator is only available on an annual basis, we divided it by 4 and used that as the quarterly deflator. We ran a test for seasonality for real quarterly GDP using deflator. No seasonality was found. However, we find seasonality for real quarterly GDP that was estimated through use of the CPI as a deflator. We also found that both data sets are positively and highly correlated. For convenience, the acronyms (dfl) and (cpi) will be used to refer to which real quarterly GDP data are being used.

(2) Narrow Money

Narrow money = Currency Outside Banks + Demand Deposits.

(3) Broad Money

Broad money = Narrow Money + Quasi Money.

Quasi money = Time Deposits + Saving Deposits + Foreign Currency Deposits.

(4) Interest Rate

In this study, interest rate refers to the rate at which the BoL offers to lend to commercial banks on a short-term basis.

(5) Consumer Price Index (CPI)

The calculation of CPI in Laos is similar to that in other countries, and is based on the weighted average price of a basket of goods and services.

<u>Seasonality, unit root and cointegration test</u>

Using X12-ARIMA, we ran seasonality tests on the variables and found moving seasonality for real GDP, CPI, quasi money and broad money at the 5, 1, 1 and 1 percent levels of significance respectively. Therefore, we adjusted our data for seasonality and decided to have two data sets: one adjusted and the other unadjusted for seasonality. One reason for using both sets of data

was that by applying seasonality filtering, the time-series dynamics may be affected and therefore affecting the outcome of Granger causality tests.

The Augmented Dickey-Fuller (ADF) test was then used to check for stationarity in the variables. Our test results showed that most variables are integrated of order one (I(1)), except for CPI which appears to be integrated of order two (I(2)). The complete results are shown in table A1 in the appendix. As a check on the ADF test, we performed another unit root test, the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, which suggested that all of our variables are I(1) as shown in table A2 in the appendix. This suggests that we should be modelling in log-differences of the variables. However, we could still estimate the model in log-levels if the variables were cointegrated. Thus, the Johansen cointegration test was applied to see if there was any evidence of their being a cointegrating vector of the included I(1) variables. The Johansen test results suggest that the variables were cointegrated as summarized in table A3 in the appendix.

Model Testing

Our study used distributed lag models (excluding the contemporaneous value of the right-hand side variables) to test whether the lagged coefficients of money have explanatory power for output or not. In the first step, we ran a model with two variables: money and output, with output being the dependent variable. This allowed us to determine if there was any direct effect of money on output and test for H1.

In the second model, we added CPI and then interest rate consecutively. This enabled us to test for H2. H3 was tested using broad money as the exogenous variable instead of narrow money. All models were estimated in log-levels and log-differences of the variables. To test for H4, we proceeded as for testing hypotheses H1, H2 and H3, but a time trend was added to the model in log-levels.

Lastly, testing for H5 involved three different types of tests and only the full multivariate model was considered, which include both CPI and interest rate. Here, the estimation was done only in log-differences because we were interested to test how the direction of the money growth affects the outcome of money-output Granger causality test as suggested by Thoma (1994). The lag length used was the same as those used for H1, H2 and H3. Three different types of tests were conducted and are explained in more detail as follows.

In test type 1, four new variables were generated. Money growth was decomposed into two variables: positive money growth (ΔMPlus) and negative money growth (ΔMMin). When money growth is positive, ΔMPlus = money growth and zero otherwise; and when money growth is negative, ΔMMin = money growth and zero otherwise. In the next step these variables were connected to the business cycle by multiplying them to a variable representing the business cycle to form ΔMCyPlus and ΔMCyMin. The variable representing the business cycle was constructed

as the residuals of a regression of the growth of GDP on a constant and a deterministic time trend. The four new variables: ΔMPlus, ΔMMin, ΔMCyPlus and ΔMCyMin were then substituted for money growth in the model.

Test type 2 was conducted to account for boom and recession periods. First, the residuals representing the business cycle were decomposed into two dummy variables: boom and recession. If the value of the residual is positive it will take a value of one under a boom, and zero otherwise; contrariwise, if the value of the residual is negative it will take a value of one under a recession, and zero otherwise. Next we multiply these two dummies with ΔMPlus and ΔMMin so that we have: ΔMPlusBm = ΔMPlus(x)boom, ΔMPlusRe = ΔMPlus(x)recession, ΔMMinBm = ΔMMin(x)boom and ΔMMinRe = ΔMMin(x)recession. These variables: ΔMPlusBm, ΔMPlusRe, ΔMMinBm and ΔMMinRe are then substituted into the model.

Test type 3 followed an approach used by Thoma (1994). His approach was based on the concept that the sensitivity of the test for Granger causality money-output could be conditioned on the direction of the growth of money; that is, whether money growth is increasing or decreasing. He argued that an increasing money growth rate could have a different effect than a decreasing money growth. To conduct this test, we first constructed a variable that represents the change in the money growth rate which we could interpret as the growth rate is increasing or decreasing. Increasing money growth rate is indicated by ΔΔMPlus equalling the rate of change of money growth when money growth is increasing and zero otherwise. Similarly, ΔΔMMin equals the rate of change of money growth when money growth is decreasing, and zero otherwise. Then ΔΔMPlus and ΔΔMMin are multiplied by the business cycle to get ΔΔMCyPlus and ΔΔMCyMin. Thus, our new four variables are: ΔΔMPlus, ΔΔMMin, ΔΔMCyPlus and ΔΔMCyMin and these were substituted into the model.

Before we tested whether the lagged coefficients of money have explanatory power on output or not, a lag length needed to be selected. Thornton and Batten (1985) have shown that the choice of the lag length selection can greatly influence the significance of the causality test; however, there is no one best solution to choose a length. The selection of lag length is usually chosen on either or both the equation being free from autocorrelation and at least one of the information criteria being significant. The various information criteria calculated were: the log likelihood ratio (LR) test, the Akaike information criterion (AIC), the Schwarz information criterion (SC), or the Hanna-Quinn information criterion (HQ). In our study, the significance of the lag length of the dependent variable was tested at the 5 percent level. Once a lag length satisfied all three criteria, an exclusion test on the coefficients of money was applied. The same procedure was used to test for Granger causality from output to money.

IV. Testing the hypotheses and results

Tables (1) through (4) are arranged similarly and summarise the various tests for Granger causality. Working from left to right across each table, columns two to five summarise the results for the seasonally unadjusted data set. The test results for the seasonally adjusted data are summarised in columns six to nine. The summaries for the direction of causality "money to output" are provided in columns two, three, six and seven. Columns four, five, eight and nine summarise the results for the direction of causality "output to money". For each group of tests, the first test results are on a "log-levels" basis and then followed by the "log-diff" basis.

Table (1) exhibits the results of the Granger causality test for narrow money. The first column explains the variables used in the model. The numbers provided in tables (1) and (4) are the lag length with the significance level being indicated by one or more "*". Statistical significance for Granger causality is indicated at the 1 percent (**) and 5 percent (*) levels. Table 2 summarizes the results for Granger causality test on broad money in the same manner as for narrow money in table (1).

Table 1. Granger Causality for narrow money

	Seasonally Unadjusted Data Set				Seasonally Adjusted Data Set			
	Money to Output		**Output to Money**		**Money to Output**		**Output to Money**	
	Log-level	Log-diff	Log-level	Log-diff	Log-level	Log-diff	Log-level	Log-diff
Money, Output(dfl)	4**	5	1*	1	4**	5	1	1
Money, Output(dfl), CPI	3**	5	1*	1	4**	5	8	4
Money, Output(dfl), CPI, Interest Rate	3**	4	2	1	3**	5	8	5
Money, Output(cpi)	3**	4	1	1	3**	5	1	1
Money, Output(cpi), CPI	3**	5	1*	1	3**	5	8	3
Money, Output(cpi), CPI, Interest Rate	3**	5	2	1	3**	5	6	4

Note: The (*) signifies the significance at 5 percent and (**) at 1 percent.

Table 2. Granger Causality for broad money

	Seasonally Unadjusted Data Set				Seasonally Adjusted Data Set			
	Money to Output		**Output to Money**		**Money to Output**		**Output to Money**	
	Log-level	Log-diff	Log-level	Log-diff	Log-level	Log-diff	Log-level	Log-diff
Money, Output(dfl)	4*	5	4**	3**	4**	5	1	1
Money, Output(dfl), CPI	3**	5	2**	1**	4**	5	8	4
Money, Output(dfl), CPI, Interest Rate	3**	5	2**	1**	3**	5	6	4
Money, Output(cpi)	6**	5	4**	3**	3**	5	1	1
Money, Output(cpi), CPI	3**	5	4	3*	3**	5	8	7
Money, Output(cpi), CPI, Interest Rate	3**	5	4*	3*	3**	5	6	4

Note: The (*) signifies the significance at 5 percent and (**) at 1 percent.

Testing the validity of the first hypothesis *(**H1**: Money Granger causes output in a two variables model),* provided us with strong supporting evidence that in Laos, at a 1 percent significance level, money Granger causes output under log-levels in both the bivariate and multivariate models but not in log-differences. Our results are similar to the findings of Christiano and Ljungqvist (1988). When testing for the opposite causality direction (output to money), the results are unclear. For example, when seasonally unadjusted data set is used, there is statistical significance that output Granger causes money, but this is not supported when seasonally adjusted data is used. When log-differences are used, output appears to have a higher statistical significance in explaining broad money than narrow money suggesting that there is a strong relationship between real output and broad money.

Moving to hypothesis two *(**H2**: In a multivariate model, the inclusion of other variables will reduce the statistical significance of the effects of money on output)*, our evidence shows that the statistical significance of causality running from money to output does not decline, which supports the results from Hayo (1999) but rejects Sims (1980).

Under the test of hypothesis three *(**H3**: It is more likely to find Granger causality when employing broad money than narrow money.)*, we also do not find evidence that by using broad money, the power of the statistical significance is higher than that of narrow money. Therefore, our results contradict King and Plosser's (1984).

Table 3. Granger Causality for narrow money with trend

	Seasonally Unadjusted Data Set		Seasonally Adjusted Data Set	
	Money to Output	**Output to Money**	**Money to Output**	**Output to Money**
	Log-level	Log-level	Log-level	Log-level
Money, Output(dfl)	2	1	4	1
Money, Output(dfl), CPI	2	1	3	8
Money, Output(dfl), CPI, Interest Rate	2	1	3	1
Money, Output(cpi)	2	1	2	8
Money, Output(cpi), CPI	3	1	3	8
Money, Output(cpi), CPI, Interest Rate	3	1	3	1

Note: The (*) signifies the significance at 5 percent and (**) at 1 percent.

Table 4. Granger Causality for broad money with trend

	Seasonally Unadjusted Data Set		Seasonally Adjusted Data Set	
	Money to Output Log-level	**Output to Money** Log-level	**Money to Output** Log-level	**Output to Money** Log-level
Money, Output(dfl)	2	1**	4	1
Money, Output(dfl), CPI	2	2**	3	8
Money, Output(dfl), CPI, Interest Rate	2	2**	3	1
Money, Output(cpi)	5	1**	2	8
Money, Output(cpi), CPI	3	4	3	8
Money, Output(cpi), CPI, Interest Rate	3	3**	3	1

Note: The (*) signifies the significance at 5 percent and (**) at 1 percent.

Testing hypothesis four (***H4****: Evidence for Granger causality can be found more easily when specifying the variables in log-levels with a deterministic time trend model instead of yields log-differences.),* our results show that by adding a deterministic trend into the model estimated in log-levels, the statistical significance of money for explaining output disappears. This contradicts the results in Hafer and Kutan (1997). Furthermore, as discussed in Krol and Ohanian (1989), the removal of trend should increase statistical inference but they also do not find evidence in the case of the U.K., Japan, Canada and Germany. An exception is the U.S. This implies that there are differences among countries' characteristics.

Table 5: Asymmetry Results (seasonally adjusted)

For narrow money

Test type 1	ΔMPlus =0	ΔMMin=0	ΔMPlus = ΔMMin =0	ΔMCyPlus =0	ΔMCyMin =0	ΔMCyPlus= ΔMCyMin =0	Δ all M =0
Narrow Money (dfl)				*			
Narrow Money (cpi)							

Test type 2	ΔMPlusBm =0	ΔMPlusRe =0	ΔMPlusBm =ΔMPlusRe =0	ΔMMinBm =0	ΔMMinRe =0	ΔMMinBm= ΔMMinRe =0	Δ all M =0
Narrow Money (dfl)					*		
Narrow Money (cpi)							

Test type 3	ΔΔMPlus =0	ΔΔMMin =0	ΔΔMPlus= ΔΔMMin= 0	ΔΔMCyPlus =0	ΔΔMCyMin =0	ΔΔMCyPlus =ΔΔMCyMin =0	ΔΔ all M =0
Narrow Money (dfl)							
Narrow Money (cpi)							

For broad money

Test type 1	ΔMPlus =0	ΔMMin =0	ΔMPlus= ΔMMin =0	ΔMCyPlus =0	ΔMCyMin =0	ΔMCyPlus= ΔMCyMin =0	Δ all M =0
Broad Money (dfl)							
Broad Money (cpi)							

Test type 2	ΔMPlusBm =0	ΔMPlusRe =0	ΔMPlusBm =ΔMPlusRe =0	ΔMMinBm =0	ΔMMinRe =0	ΔMMinBm =ΔMMinRe =0	Δ all M =0
Broad Money (dfl)					*		
Broad Money (cpi)							

Test type 3	ΔΔMPlus =0	ΔΔMMin =0	ΔΔMPlus= ΔΔMMin =0	ΔΔMCyPlus =0	ΔΔMCyMin =0	ΔΔMCyPlus =ΔΔMCyMin =0	ΔΔ all M =0
Broad Money (dfl)							
Broad Money (cpi)							

Note: The (*) signifies the significance at 5 percent and (**) at 1 percent.

Table 6: Asymmetry Results (seasonally unadjusted)

For narrow money

Test type 1	ΔMPlus =0	ΔMMin = 0	ΔMPlus = ΔMMin = 0	ΔMCyPlus =0	ΔMCyMin =0	ΔMCyPlus = ΔMCyMin =0	Δ all M = 0
Narrow Money (dfl)					**	*	
Narrow Money (cpi)					**	*	

Test type 2	ΔMPlusBm =0	ΔMPlusRe =0	ΔMPlusBm =ΔMPlusRe =0	ΔMMinBm = 0	ΔMMinRe = 0	ΔMMinBm =ΔMMinRe =0	Δ all M = 0
Narrow Money (dfl)							
Narrow Money (cpi)							

Test type 3	ΔΔ MPlus = 0	ΔΔ MMin = 0	ΔΔ MPlus = ΔΔ MMin = 0	ΔΔMCyPlus =0	ΔΔMCyMin =0	ΔΔMCyPlus =ΔΔMCyMin =0	ΔΔ all M = 0
Narrow Money (dfl)							
Narrow Money (cpi)							

For broad money

Test type 1	ΔMPlus =0	ΔMMin=0	ΔMPlus= ΔMMin=0	ΔMCyPlus =0	ΔMCyMin =0	ΔMCyPlus =ΔMCyMin =0	Δ all M = 0
Broad Money (dfl)							
Broad Money (cpi)							

Test type 2	ΔMPlusBm =0	ΔMPlusRe =0	ΔMPlusBm =ΔMPlusRe =0	ΔMMinBm =0	ΔMMinRe =0	ΔMMinBm= ΔMMinRe= 0	Δ all M = 0
Broad Money (dfl)							
Broad Money (cpi)							

Test type 3	ΔΔMPlus =0	ΔΔMMin =0	ΔΔMPlus= ΔΔMMin=0	ΔΔMCyPlus =0	ΔΔMCyMin =0	ΔΔMCyPlus =ΔΔMCyMin =0	ΔΔ all M = 0
Broad Money (dfl)					**	*	
Broad Money (cpi)							

Note: The (*) signifies the significance at 5 percent and (**) at 1 percent.

Moving to our last hypothesis (***H5****: Allowing for asymmetric effects of money on output growth and including the business cycle greatly influences results and strengthens the causal effect of money)*, tables (5) and (6) show the results when asymmetries were accounted for in the model. The results from the three different types of tests leave us with some evidence that asymmetries have influence on money-output Granger causality. Using the seasonally adjusted data set, we find that: positive money (narrow) growth is associated with the upswing in the business cycle; that negative money growth is associated with the recession periods; and in both cases of positive and negative growth, narrow money growth is significant in explaining output growth. For broad money, we find that only negative money growth in association with recession periods has significant influence on output growth. When the seasonally unadjusted data set is used, we find that for both narrow and broad money, negative money growth associated with the business cycle and a decreasing money growth associated with the business cycle has significant impact on output growth at the 1 percent level. This suggests that asymmetric effects due to positive and or negative money growth do matter on money-output Granger causality tests.

V. Conclusion

Does money Granger cause output in Laos? Based on our empirical results we have drawn five main conclusions regarding the characteristics of the causality of money-output for Laos. Firstly, when log-levels are used there is strong evidence that money Granger causes output; secondly, when log-differences are used the opposite is true; thirdly, the inclusion of additional variables into the models does not appear to make a significant difference for the statistical results; fourthly, when a time trend is added to the model, the significance of money on output disappears; and fifthly, when allowing for asymmetries in the models, there is very little evidence that money Granger causes output.

Our empirical results share similarities with studies by Christiano and Ljungqvist (1988), Krol and Ohanian (1990), Stock and Watson (1989), and Hafer and Kutan (1997). All find evidence for causality running from money to output when the data is measured in log-levels, but not in

first differences. Christiano and Ljungqvist (1988) try to explain this difference by conducting bootstrap simulation experiments. From the experiments, they find that the most likely explanation for this difference is that the small F-statistic based on the difference data reflects not the data's lack of Granger-causality from money to output, but rather the test's lack of power to detect it. Thus, they argue that based on their data set; first differencing the data appears to entail a specification error and conclude that money does Granger-causes output as supported by the estimation in log-levels.

Comparing the estimation results from the estimation in log-levels and log-levels with a linear time trend, they suggest that money significantly Granger-causes output at the 1 percent confidence interval but this significance disappears completely when a linear time trend is added. Krol and Ohanian (1990) argued that when they apply the study to five countries, they find that even though the data in these countries are characterized by deterministic time trends, the trend removal procedure is not significant for countries other than the U.S. Similarly in Hayo's (1999) findings when the study is applied to a broader group of countries, the inclusion of a deterministic trend does not make any difference to the test results. It appears to be that different test results on the removal of trend could be sensitive to the period and be country specific. The studies mentioned are of developed and industrialized countries; we don't know if this would be the same for developing and less industrialized economies. This would be an interesting topic for further investigation whether the results are sensitive to the removal of the trend when applied to a broader group of developing or emerging markets. For now, due to the uncertainty of the debate on this aspect, we consider that it is sufficient to rely on the results from the estimation in levels for the significance of any causality.

By relying on the results from the log-levels estimation, it suggests that money does Granger-causes output for both narrow and broad money. This implies that the monetary authority in Laos could successfully affect the business cycle through the conduct of monetary policy. However, to implement a policy that will be effective, it is also important to know how long it would take for a policy decision to take effect. Timing mismatches, in particular due to the lags in data being available, could result in policy not achieving the target objectives and possibly worsening the situation. Therefore, we feel that further research could be done to study the impact of the monetary transmission mechanism to understand how monetary policy is transmitted to the economy via different channels, the time it needs to take effects and whether it will hinder or complement the impact of monetary policy on macroeconomic targets.

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Appendix

Table A1: Unit root tests (ADF-test)

Null hypothesis = Non stationarity

	Constant	Constant + Linear Trend	None
Log Qrt Real GDP(dfl)	I(1)	I(1)	I(1)
Log Qrt Real GDP(cpi)	I(1)	I(1)	I(1)
Log Narrow Money	I(1)	I(1)	I(1)
Log Broad Money	I(1)	I(1)	I(1)
Log Consumer Price Index	I(2)	I(2)	I(2)
Interest Rate	I(1)	I(1)	I(1)

Table A2. Unit root tests (KPSS)

Null hypothesis = The variable has stationary

	Constant	Constant + Linear Trend
Log Qrt Real GDP(dfl)	I(1)	I(1)
Log Qrt Real GDP(cpi)	I(1)	I(1)
Log Narrow Money	I(1)	I(1)
Log Broad Money	I(1)	I(1)
Log Consumer Price Index	I(1)	I(1)
Interest Rate	I(1)	I(1)

Table A3: Cointegration tests (Johansen-Method)	**Trace Statistic Test**	**Max-eigenvalue Test**
Log Qrt Real GDP(dfl), Log Narrow Money	*	*
Log Qrt Real GDP(dfl), Log Narrow Money, Log Consumer Price Index	*	*
Log Qrt Real GDP(dfl), Log Narrow Money, Log Consumer Price Index, Interest Rate	*	*
Log Qrt Real GDP(dfl), Log Broad Money	*	*
Log Qrt Real GDP(dfl), Log Broad Money , Log Consumer Price Index	*	*
Log Qrt Real GDP(dfl), Log Broad Money , Log Consumer Price Index, Interest Rate	*	*
Log Qrt Real GDP(cpi), Log Narrow Money	*	*
Log Qrt Real GDP(cpi), Log Narrow Money, Log Consumer Price Index	*	*
Log Qrt Real GDP(cpi), Log Narrow Money, Log Consumer Price Index, Interest Rate	*	*
Log Qrt Real GDP(cpi), Log Broad Money	*	*
Log Qrt Real GDP(cpi), Log Broad Money , Log Consumer Price Index	*	*
Log Qrt Real GDP(cpi), Log Broad Money , Log Consumer Price Index, Interest Rate	*	*

Note: (*) indicates statistical significance at 5% level

Section 3

The demand for money in the Lao People's Democratic Republic: evidence from cointegration test

The demand for money in the Lao People's Democratic Republic: evidence from cointegration test

Vimaly Savannarideth

Philipps University Marburg, Department of Business and Economics, Universitaetsstraße 25, D-35037 Marburg. Email: Savannar@students.uni-marburg.de.

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Abstract. This paper examines the stability of a real-money demand function for Laos. A model was estimated with data for the period March 1993 to December 2010. The model was then tested with out-of-sample data over the period January 2011 to December 2012. Within the framework of a small, vector autoregression model, the Johansen cointegration test is adopted to investigate the presence of a long-run relationship between real money (both broad money and narrow money), real output and interest rate. The empirical results demonstrate that a long-run relationship exists for the money demand function, both for narrow and broad money, with components that are significant and meaningful for economic interpretation. This suggests that the money demand function in Laos is stable in the long-run. Furthermore, it may support the central bank (the Bank of Lao PDR, "BoL") in using money supply as an intermediate target to control inflation. In addition, an out-of-sample stability test through one-step ahead forecasts shows that the overall forecasts are reasonably stable.

JEL Classification: E41; E52

Keywords: monetary economics, money demand function, cointegration test, Laos.

1. Introduction

The purpose of this paper is to empirically investigate the stability of a money demand function in Laos. The "Memorandum on Economic and Financial Policies of the Government of the Lao People's Democratic Republic for 2001" highlighted that monetary policy will remain prudent in order to achieve a sustained reduction in inflation. This places monetary policy as the primary policy for price stability. The investigation of money demand stability is then an important question for the central bank. This is because general stability in the money demand function is an important pre-condition to be able to draw the conclusion that money supply has a certain predictable level of influence on the real economy. In such a case, "*the central bank's control of the money supply will more likely to be effective as a way of implementing monetary policy*" (Hamori & Hamori, 2008). In other words, as Hamori & Hamori (2008) argued, if there does exist a stable relationship between the real money balance and other variables, such as real GDP and interest rates, then there should be a stable long-term relationship between the nominal money supply and prices.

To assist in identifying the long-run relationship of the money demand function, it is necessary to test for cointegration. Examples of empirical cointegration tests in developed countries include: Hafer & Jansen (1991), Miller (1991), Friedman & Kuttner (1992), Hansen & Kim (1995), Wesche (1997), Fase & Winder (1998), Hayo (1999, 2000), Coenen & Vega (2001), and Hamori & Hamori (2008). Similarly, for developing countries, among others, Hamori (2008) finds evidence for cointegration for the Sub-African region, Sumner (2009) for Thailand, and Bahmani-Oskooee & Rehman (2005) for Asian developing countries. Specifically for Laos, to our knowledge, so far only one relevant study by Dat, Hoa, & Phaysith (2012) is found. Their empirical results suggest a stable relationship for money demand for the period 1993Q1 to 2010Q2. The equilibrium is stable for the included variables: real money, real GDP, real Kip per Baht exchange rate, real Kip per US dollar exchange rate and real saving US dollar interest rate. Given the results, they recommend that the BoL can use money as an intermediate target for monetary policy.

This paper seeks to extend the literature on money demand in Laos in several directions. Using a vector autoregeression (VAR) framework, the Johansen cointegration test is applied to identify the existence of the long-run equilibrium. The analysis is followed by restriction tests of the estimated cointegrating and adjustment vectors. By employing the restriction test on the cointegrating vector, it is possible to test the classical money demand theory by assuming a unit income elasticity of money demand and zero interest rate semi-elasticity. In accordance with Johansen (1992a, 1992b), the restriction test on the adjustment vector can help us determine if one could estimate the demand for money equation in a system of equations or not. In contrast to Dat, Hoa, & Phaysith (2012), this paper adopts a simple money demand function model. As argued by Hayo (2000) a simple model comes with several advantages. In particular, a simple model provides the analysis with a relatively

large degree of freedom, and enough observations for an out-of-sample analysis. Out of sample analysis is important when examining the stability of an estimated demand for money equation.

The rest of the paper is organized as follows: empirical model and database are covered in the next section, econometric approach and results are provided in section 3 with details about the unrestricted and restricted cointegration analyses. Section 4 presents details of the short-run dynamic estimation including the out-of-sample forecasts. Finally, section 5 summarizes the empirical results.

2. Econometric specification and database

There are various theoretical specifications of the money demand function. This paper adopts a simple model, which was used in Hayo (1999, 2000) and Hamori & Hamori (2008). As argued by Hayo (2000), a simple model allows several advantages which include: i) a relatively large degree of freedom, ii) leaves enough observations for out-of-sample analyses and iii) avoids the danger of over-fitting the equations to the specific samples at hand.

The long-run theoretical relationship of the money demand function is specified as follows:

$$LM_t \text{ (or LMQ)} = ß_1 LGDP_t + ß_2 INT_t + \mu_t, \quad (1)$$

where:

LM = log of real narrow money;

LMQ= log of real broad money;

LGDP = log of real GDP;

INT = interest rate;

$ß_1$ = income elasticity of money demand;

$ß_2$ = interest rate semi-elasticity of money demand; and

μ_t = white-noise error.

The data used in this study is retrieved from Allthatstat.com. Allthatstat.com sourced the Laos data used in this paper from the International Monetary Fund. The sample period covers May 1993 to December 2012 on a monthly basis.

Laos' GDP data is not available on a monthly basis. Monthly GDP data were estimated by applying a best linear unbiased estimation technique developed by Chow & Lin (1971). The technique has a number of steps.

In the first step, several regression models where GDP is regressed on import and export on an annual basis are compared. Using information criteria for model selection, the best estimation model is $GDP = \alpha + ß_1 Export_t + ß_2 Export_{t-1} + ß_3 Import_t + ß_4 Import_{t-1+} ß_5 Import_{t-2} + \varepsilon$.

In the second step, given that monthly import and export data are not available, they are derived from equally splitting quarterly data and are then multiplied by the estimated coefficients: α , $ß_1$, $ß_2$, $ß_3$, $ß_4$, $ß_5$ to obtain estimated monthly GDP.

Next, estimated annual GDP is compared to observable annual GDP, their differences are produced and divided by 12.

The differences are then used to add back to the estimated monthly GDP so that at the end, the estimated annual GDP and observable annual GDP are the same.

Finally, estimated monthly GDP is divided by the consumer price index to obtain real GDP.

Laos' one-year commercial bank deposit interest rate is used as a proxy for Laos' interest rate. As argued by Poole (1988), the weighted average of expected short-run rates in the future can be represented by the long-run interest rate. This is because he believes that agents will only change the amount of money they hold when they believe that the opportunity cost of holding money is not transitory. Poole (1988)'s argument fits reasonably well to the market situation in Laos where real short-term interest rates are significantly lower and more volatile than real longer-term interest rates. Therefore, agents are more likely to use the long-run interest rate as their opportunity cost of holding money.

3. Econometric approach and results

3.1 Seasonality, unit root and cointegration tests

To test for seasonality of the variables, the X-12 ARIMA seasonal adjustment method was used. The results show that only narrow money exhibits seasonality. Seasonal "dummy variables" were applied to adjust for the seasonal effects. The details of the tests can be provided upon request.

The Augmented Dickey-Fuller (ADF) test was used to check for stationarity in the variables. These results are shown in detail in table (1). The results suggest that the variables are integrated with order one (I(1)). The ADF test strongly indicates, at a significance level -9.61, that real GDP is trend stationary. However, we cannot reject the null hypothesis that real GDP is non-stationary. This is because the ADF test statistic determined "without constant or linear trend" at the 5 percent level is greater than -1.95.

To further test for the existence of a unit root, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test was applied. The results suggest that real GPD is non-stationary when a constant is added to the test specification. The details of the tests are provided in table (2). To investigate whether there was some lag structure to any trend that may be present, the ADF test was applied with different lag lengths. These ADF tests with different lag lengths confirmed that we cannot reject that real GDP is non-stationary, I(1), except when a trend is included.

Table 1. Augmented Dickey-Fuller test

ADF test	**with constant**	**with constant and linear trend**	**without constant or linear trend**
Test at log-level	ADF statistic	ADF statistic	ADF statistic
Log real narrow money	0.21	-1.70	1.58
Log real broad money	0.75	-1.59	3.65
Log real GDP	-2.88*	-9.61*	2.18
Log of consumer price index	-1.80	-0.73	1.88
Interest rate	-0.41	-1.90	-1.12
Test at first difference			
△Log real narrow money	-12.85*	-9.19*	-12.7*
△Log real broad money	-15.55*	-17.6*	-14.7*
△Log real GDP	-7.96*	-7.95*	-9.31*
△Log of consumer price index	-5.40*	-5.66*	-4.73*
△Interest rate	-9.85*	-9.87*	-9.79*
Automatic lag selection base on Schwarz information criterion with maximum lag=13. Null hypothesis: Variable has a unit root. One asterisk indicates a rejection of the Null at 5 percent significance level.			

The Johansen cointegration test was used to identify the cointegration vector of the included I(1) variables: LM(or LMQ), LGDP and INT. The cointegration test examined the period 1993M05 to 2010M12 leaving 24 months for out-of-sample testing. Starting with maximum lag length of 12, the variables were formed into a VAR framework and estimated. Then, each estimated lag VAR system from 12 to lag 1 was compared using information criteria. The various information criteria used were: the Log likelihood ratio (LR) test, Akaike information criterion (AIC), Schwarz information criterion (SC) and Hanna Quinn information criterion (HQ) to identify the appropriate lag length. The lag lengths suggested by each information criterion were compared based on the number and stability of the cointegrating vector(s). It was found that there exists one significant stable cointegrating vector for both narrow and broad money with a lag length of 11. Details of the test results are shown in table (3).

Table 2. Kwiatkowski-Phillips-Schmidt-Shin test

KPSS test	**with constant**	**with constant and linear trend**
Test at log-level	KPSS statistic	KPSS statistic
Log real narrow money	1.66*	0.45*
Log real broad money	1.98*	0.42*
Log real GDP	1.96*	0.10
Log of consumer price index	1.70*	0.45*
Interest rate	1.60*	0.30*
Test at first difference		
△Log real narrow money	0.29	0.05
△Log real broad money	0.39	0.09
△Log real GDP	0.03	0.02
△Log of consumer price index	0.54*	0.12
△Interest rate	0.05	0.04
Spectral estimation method: Bartlett Kernel, Bandwidth: (Newey-west using Bartlett Kernel). Null hypothesis: Variable is stationary. One asterisk indicates a rejection of the Null at 5 percent significance level.		

Table 3: Estimating and testing cointegrating vectors for narrow and broad money

Narrow money		Lag length: 11		**Broad money**		Lag length: 11	
H_0	Eigenvalue	LR(r, r+1)	LR(r, N)	H_0	Eigenvalue	LR(r, r+1)	LR(r, N)
r = 0	0.21	48.57*	50.07*	r = 0	0.11	22.78*	29.48*
r ≥ 1	0.007	1.43	1.50	r ≥ 1	0.03	6.48	6.7
r ≥ 2	0.00	0.06	0.07	r ≥ 2	0.00	0.22	0.22

Notes: LR(r, r+1) is the test statistics for the maximum eigenvalue test, and the LR(r,N) for the trace test. One asterisk indicates a rejection of the Null at the 5% significance level. The critical values are taken from MacKinnon-Haug-Michelis (1999).

3.2 Unrestricted cointegration analysis for narrow and broad money

As discussed in the previous section, the Johansen cointegration test provided evidence that there is a cointegrating vector for both narrow and broad money. The unrestricted long-run cointegrating equation for narrow money is LM – 0.77LGDP + 0.17INT. This result is intuitively appealing: a change in real GDP exerting a positive effect on real narrow money growth, with a change in the interest rate having a negative effect on real narrow money growth. This long-run equilibrium can be interpreted for example, if there is an increase in LGDP by 1 percent, LM will increase by 0.77 percent and if INT is to increase by 1 percentage point, then LM will decrease by 0.17 percent. The

adjustment coefficient of the long-run equilibrium takes a value of -0.07 and it is significant, which suggest that the tendency to return to equilibrium after a shock is very small.

For broad money, the long-run equilibrium equation is LMQ - 1.37LGDP + 0.28INT with a significant adjustment coefficient that takes a value of -0.008. Again the interpretation of the long-run equilibrium is such that, if LGDP increases by 1 percent, LMQ is expected to increase by 1.37 percent, which is more than a unit-to-unit increase. For the interest rate, if INT is to increase by 1 percent, LMQ is expected to decrease by 0.28 percent. For broad money, it appears that the size of the coefficients of LGDP and INT are stronger than for narrow money.

3.3 Restricted cointegration analysis for narrow and broad money

Table (4) shows results of testing the restrictions on cointegrating and adjustment vectors for narrow money. First, the restriction test for the cointegrating vector is performed. In this test, the classical money demand theory is being tested by assuming a unit income elasticity of money demand and a zero interest rate semi-elasticity. The results suggest that the restrictions have to be rejected at a 5 percent significance level. The same is true when dropping the constraint on the interest rate, suggesting that income does not have a one-to-one relationship with money demand.

In the next test, given that any restriction is rejected on the cointegrating vector, the unrestricted cointegrating vector is carried over and a restriction on the adjustment vector is introduced. The test is performed with the hypothesis that income and interest rate variables are weakly exogenous with respect to the money demand equation. To test this hypothesis, income and interest rate variables are constrained to equal to zero. The results suggest that the hypothesis is rejected. The hypothesis is also rejected when the zero constraint is dropped for the income variable but accepted when the zero constraint is dropped for the interest rate variable. This means that only the income variable is weakly exogenous with respect to the money demand equation. Thus, the dynamic model is to be carried out by estimation within a two-equations system namely, the money and the interest rate equations with the corresponding error correction term being: $LM_{t-1} - 0.76LGDP_{t-1} + 0.17INT_{t-1}$ that has a significant loading parameter of -0.07.

Table 4: Test restriction on cointegrating vector and adjustment parameters for narrow money

LR test for binding restrictions (rank =1) LR test of restrictions:

LM	LGDP	INT	Chi-square	Probability	Result
1	-1	0	Chi-square(2)= 27.05	0.00	Reject restriction.
1	-1	Unrestricted	Chi-square(1)= 4.60	0.03	Reject restriction.

Cointegration test (rank:1) with specification: No intercept or trend in CE and VAR

LR test for binding restriction (rank=1) LR test of restrictions:

LM	LGDP	INT	△LM	***△LGDP***	***△INT***	Chi-square	Probability	Result
1	Unrestricted	Unrestricted	Unrestricted	***0***	***0***	Chi-square(2)= 7.80	0.02	Reject restriction.
1	Unrestricted	Unrestricted	Unrestricted	***0***	***Unrestricted***	Chi-square(1)= 0.70	0.40	Accept restriction.
1	Unrestricted	Unrestricted	Unrestricted	***Unrestricted***	***0***	Chi-square(1)= 6.56	0.01	Reject restriction.

Cointegration test (rank:1) with specification: No intercept or trend in CE and VAR

Table 5: Test restriction on cointegrating vector and adjustment parameters for broad money

LR test for binding restrictions (rank =1) LR test of restrictions:

LMQ	LGDP	INT	Chi-square	Probability	Result
1	-1	0	Chi-square(2)= 6.98	0.03	Reject restriction.
1	-1	Unrestricted	Chi-square(1)= 0.24	0.62	Accept restriction.

Cointegration test (rank:1) with specification: No intercept or trend in CE and VAR

LR test for binding restriction (rank=1) LR test of restrictions:

LMQ	LGDP	INT	△LMQ	***△LGDP***	***△INT***	Chi-square	Probability	Result
1	Unrestricted	Unrestricted	Unrestricted	***0***	***Unrestricted***	Chi-square(1)= 0.41	0.52	Accept restriction.
1	Unrestricted	Unrestricted	Unrestricted	***Unrestricted***	***0***	Chi-square(1)= 0.04	0.84	Accept restriction.
1	Unrestricted	Unrestricted	Unrestricted	***0***	***0***	Chi-square(2)= 0.48	0.78	Accept restriction.

Cointegration test (rank:1) with specification: No intercept or trend in CE and VAR

Table (5) details the results of the restriction test for cointegrating and adjustment vectors for broad money. Here, the classical money theory where a unit income elasticity of money demand and a zero interest rate semi-elasticity is rejected. Dropping the zero constraint on the interest rate variable and testing again shows that a unit coefficient on income cannot be rejected at a 5 percent significance level. This suggests that money and income could have a one-to–one relationship only when the interest rate is not constrained. Next, carrying the unrestricted cointegrating vector and continuing with the restriction on the adjustment vector, it is found that the income and the interest rate variable are weakly exogenous with respect to the money demand equation. Therefore, the dynamic modeling will be estimated within a one-equation system, which is the money demand equation with the error correction term of $LMQ_{t-1} - 1.54LGDP_{t-1} + 0.33INT_{t-1}$ that has a significant coefficient of -0.007.

4. Estimating short-run money demand function

In this section, the dynamic error correction models are estimated. In addition to the variables presented in section 2, inflation is added. Hayo (1999) provides two arguments that rationalize the inclusion of inflation. Hayo argues as follows:

"*First, when investors hold real assets as a large proportion of their portfolios, and assuming that the inflation rate measures the yield of real assets, then changes in the inflation rate can have an effect on the demand for money. Second, it is possible that interest rate and inflation rate are not perfectly correlated (see Baba et al., 1992) due to reasons such as distorted money and capital markets or administrative influences on the formation of interest rates.*"

However, it is not sensible to include inflation, which appears to be stationary (I(0)) into the cointegrating vector, but by adding it to the short-run dynamic model, it may have an effect on money growth. As seasonality is detected in the narrow money series, seasonal dummies are included in the estimation as well.

Modeling narrow money

The estimation starts with an unrestricted two-equation VAR in first differences of LM and INT on the lagged value of LM, LGDP, INT, Inflation (INF) in differences, the restricted cointegrating vector as a lagged error correction term and seasonal dummies. Following similar procedures as adopted in Hayo (2000), the number of lags in the unrestricted VAR are reduced based on an F-test criterion at the 5 percent significance level. For example, the F-test is applied to a group of insignificant variables and if the restriction is accepted, the reduced model is estimated. Based on the reduced model's output, we again identify a further group of variables for exclusion. Then, the F-test is applied to the first group of restrictions together with the new group of restrictions. If the restriction is accepted, we proceed to estimate the reduced model. The procedure is repeated until it is possible to eliminate as many variables as possible until only variables with a significance level of 10 percent or better remain and that the system is free from autocorrelation.

The test suggests that the reduced system is free from autocorrelation but not free from the presence of heteroskedasticity. Given that the estimation is done in a system of equations where we do not treat observations as independent across equations, in principle it is recommended to rely on the vector test. However, when examining each equation independently, we find that the △LM equation does not suffer from autocorrelation and heteroskedasticity and thus it has the correct statistical properties for inferences on the estimators. On the other hand, the △INT equation does suffer from heteroskedasticity.

In order to support the argument in favor of looking only at the △LM equation, we compute the correlation across the two residuals of △LM and △INT equations estimated in isolation. The result suggests that the correlation between the two residuals is 0.008, which is fairly low and thus gives us confidence to only look at the money demand equation for inference purposes.

Table 6: Reduced dynamic error correction model for narrow money

	Equation for: △LM				**Equation for: △INT**		
	Coefficient	**Std.Error**	**t-prob**		**Coefficient**	**Std.Error**	**t-prob**
$\triangle LM_{t-5}$	-0.11	0.07	0.10	$\triangle LM_{t-1}$	-1.33	0.73	0.07
$\triangle LM_{t-8}$	-0.11	0.06	0.07	$\triangle LM_{t-6}$	-2.48	0.74	0.00
$\triangle LGDP_{t-3}$	-0.08	0.03	0.01	$\triangle LGDP_{t-11}$	0.75	0.32	0.02
$\triangle LGDP_{t-5}$	0.07	0.03	0.01	$\triangle INT_{t-5}$	-0.33	0.06	0.00
$\triangle LGDP_{t-7}$	-0.05	0.03	0.07	$\triangle INT_{t-6}$	-0.20	0.06	0.00
$\triangle INT_{t-4}$	0.02	0.01	0.00	Dummy (Feb)	-0.51	0.18	0.01
$\triangle INT_{t-9}$	0.03	0.01	0.00				
COINTEQ	-0.06	0.01	0.00				

$\triangle INF_{t-2}$	-0.37	0.15	0.01
Dummy (Jul)	-0.07	0.02	0.00
Dummy (Jan)	-0.03	0.02	0.06
Dummy (Aug)	-0.07	0.02	0.00
Dummy (Apr)	-0.08	0.02	0.00
Dummy (Jun)	-0.05	-0.02	0.00
Dummy (Mar)	-0.07	0.02	0.00
Dummy (May)	-0.07	0.02	0.00
Dummy (Oct)	-0.03	0.02	0.07
Dummy (Sept)	-0.04	0.016	0.01

AR-test : F(4, 178) = 0.42 [0.80]	AR-test : F(4, 190) = 0.61 [0.65]
ARCH test : F(4, 192) = 0.33 [0.86]	ARCH test : F(4, 192) = 0.13 [0.97]
Normality test : Chi^2 (2) = 5.06 [0.08]	Normality test : Chi^2 (2) = 429.94 [0.00]**
Hetero test : F(27, 172) = 0.98 [0.50]	Hetero test : F(11, 188) = 11.71 [0.00]**

Vector AR-test : F(16, 358) = 0.62 [0.87]

Vector Normality test : Chi^2 (4) = 434.04 [0,00]**

Vector Hetero test : F(303, 288) = 1.81 [0,00]**

The dynamic error correction model for narrow money is shown in table (6). The equation for $\triangle$LM represents the dynamic money demand function for narrow money and the results are as follows:

(1) The error correction term (COINTEQ) has a coefficient of -0.06 with the correct sign and is significant. This implies that the deviation from the long-run equilibrium does not exert a strong pressure on the growth of real narrow money.

(2) Lagged $\triangle$LM appears to have net negative effect with $\triangle LM_{t-5}$ and $\triangle LM_{t-8}$ taking up a coefficient of -0.11 each. The total net effect sum of the contributing coefficients add ups to -0.22, which suggests that past money growth has a considerable amount of impact on real money growth today, however, the effect is not in accordance with economic theory.

(3) The income variables, namely $\triangle LGDP_{t-3,}$ $\triangle LGDP_{t-5,}$ and $\triangle LGDP_{t-7}$ are significant in explaining real money growth with coefficients of -0.08, 0.07 and -0.05 respectively. However, their effects are of mixed sign. The net total effect sums to -0.06, which is not only small in magnitude, but also does not make economic sense. To be in accordance with economic theory, we would expect a positive influence of income on money.

(4) For the interest rate variables, only $\triangle INT_{t-4}$ and $\triangle INT_{t-9}$ are significant in explaining real narrow money growth. Each of these has a positive coefficient, they sum to a modest 0.05. Economic intuition would expect a negative contribution as interest rates are expected to have a negative influence on money demand. The higher the interest rate, the more costly the opportunity cost of holding money and therefore, increasing interest rates should induce less money demand.

(5) When looking at the inflation variable in the model, it appears that inflation does have a strong negative effect on the growth of narrow money with a coefficient of -0.37. The magnitude is large and it is the only variable in the equation that exhibits the right sign in accordance with economic theory. This suggests that inflation is an important factor in the short-run demand for narrow money and affects how agents decide on their money holding. This result is opposite to what is found in Hayo (2000). Hayo found that inflation is not significant as a regressor in the narrow money growth equation for Austria, but significant for M2 and M3 money growth equations. However, it should be borne in mind that the financial and economic environments of Laos and Austria are quite different and so results may differ too. For instance, if an agent holds 100 Kip, and the price of a basket of goods in Kip keeps rising from 20 to 30 to 40 to 50 Kip then the value of holding 100 Kip is decreasing at the speed of the increase in price of the basket of goods. When such scenario occurs, in the agent's mind, he faces the uncertainty of the value of Kip to purchase a basket of good today and in the future. So one of the responses that may occur in this scenario, given the presence of available currency substitution, is to convert the holding into US dollars, euro or Thai Baht, and when necessary, convert just the right amount to purchase the basket. Given also past experience of high depreciation of Kip associated with high inflation, this process, at least in the agent's mind is more viable or stable for his holding. This has led to low trust in the Kip as a store of value. In addition, the Kip is not freely convertible. If businesses need to buy goods and services in foreign currencies and/or receive revenue in foreign currencies, they are not necessarily able to convert their Kip into another currency on demand. Thus, we find that money at least in narrow terms reacts quite strongly to inflation.

(6) Some seasonal dummies are significant.

Coming to the interest rate equation represented by $\triangle$INT in the system of equations. It appears that $\triangle$INT is affected by its own lags, lagged $\triangle$LGDP and lagged $\triangle$LM. Lagged $\triangle$INT namely, $\triangle INT_{t-5}$ and $\triangle INT_{t-6}$ appear to have significant influence on the growth of interest rate with coefficients of -0.33 and -0.20 consecutively. Their total effect is relatively large but does not exhibit the correct sign. Money variables appear to have a very strong negative influence on the growth of interest rate where only $\triangle LM_{t-1}$ and $\triangle LM_{t-6}$ are significant and have a total net effect of -3.81. Lastly, only $\triangle LGDP_{t-11}$ is found to be significant with a coefficient of 0.75.

Modeling broad money

Based on the restriction test results, the money demand equation is constructed in the VAR in first differences on the lagged value of LMQ, LGDP, INT, INF in differences and the restricted cointegrating vector as a lagged error correction term. Similar procedures explained earlier for narrow money to reduce the general dynamic model are applied.

The reduced dynamic error correction model for broad money is shown in table 7. The dynamic money demand function for broad money is represented by △LMQ. Details of the results are explained next:

(1) The error correction term takes a value of -0.003. This suggests that the tendency to return to equilibrium after a shock is very weak.

(2) Income variables of lag 1 and 4 are significant in explaining the growth of broad money. They have opposite signs. Lag 1 has the correct sign with respect to economic intuition: an increase in GDP should induce higher demand for money. However, although positive, $\triangle LGDP_{t-1}$ takes a coefficient of 0.04, which is very small and is more than cancelled out by the second GDP term, $\triangle LGDP_{t-4}$. $\triangle LGDP_{t-4}$ has a coefficient of -0.08, quite strong, it is not possible to explain this intuitively. The aggregate of the two sums to -0.04.

(3) Coming to the interest rate variable, only $\triangle INT_{t-3}$ is found significant in explaining the growth of money with a coefficient of 0.007 and again, the sign is not intuitive for economic inference.

(4) It is also interesting to note that we find no inflation effect on broad money growth. The results are opposite to the case of Austria in Hayo (2000) where he finds that inflation does influence the short-run dynamic of M2 and M3: this supported his rationale for the inclusion of inflation as a proxy for real assets. In the case of Laos, reasons for these findings may be of a completely different nature. For example, in Laos, where time and saving deposits and foreign currency deposits are a large part of broad money, changes in inflation may not affect agents' holding of their deposits accounts because these accounts are of fixed term which are normally held for a long period of time. Thus, short-run changes in inflation will have little effect on such holdings. Similarly, foreign currency deposits are expected to react very little to inflation unless there are other attractive alternative assets that people could hold and that is large enough to effect the agent's decision of holding currencies.

Table 7: Reduced dynamic error correction model for broad money

Equation for: △LMQ

	Coefficient	**Std.Error**	**HCSE**	**t-HCSE**	**JHCSE**	**t-JHCSE**	**t-prob**
$\triangle LGDP_{t-1}$	0.040	0.02	0.02	1.67	0.02	1.80	0.08
$\triangle LGDP_{t-4}$	-0.080	0.02	0.03	-2.31	0.03	-2.43	0.01
$\triangle INT_{t-3}$	0.007	0.00	0.00	2.58	0.00	2.65	0.00
COINTEQ	-0.003	0.00	0.00	-4.54	0.00	-4.60	0.00

AR 1-4 test : F(4, 192) = 1.14 [0.34]
ARCH 1-4 test : F(4,192) = 1.57 [0.18]
Normality test : Chi^2 (2) = 83.55 [0.00]**
Hetero test : F(8, 191) = 2.18 [0.03]*

Out-of-sample analysis

Figures (1) and (2) depict results of the one-step forecast for the short-run dynamic error correction model for narrow and broad money represented by △LM and △LMQ. The out-of-sample forecasts for equation △LM using the one-step ahead forecasts are as shown in figure (1). It can be seen that overall the forecasts are stable and, with one exception – October 2012, within the confidence intervals (two standard errors) represented by the bars. In figure 2 the one-step forecasts for △LMQ suggest that most values stay within the confidence intervals with only two exceptions at the end of 2012.

Figure 1: Out-of-sample forecasts for △LM equation

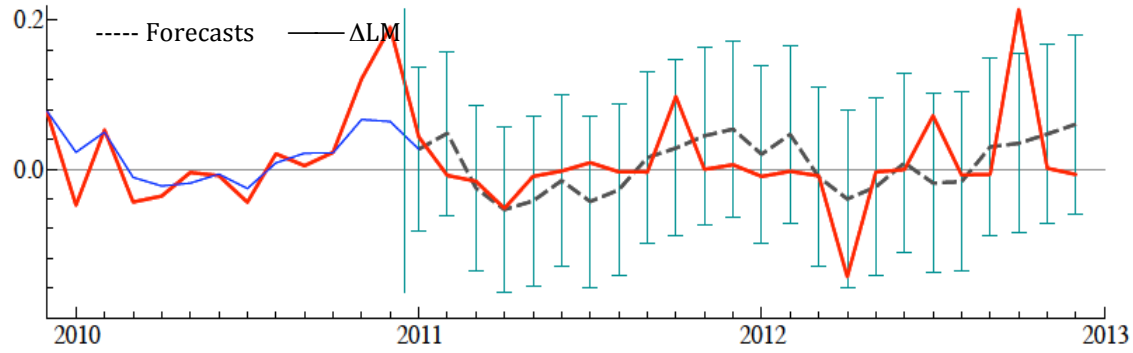
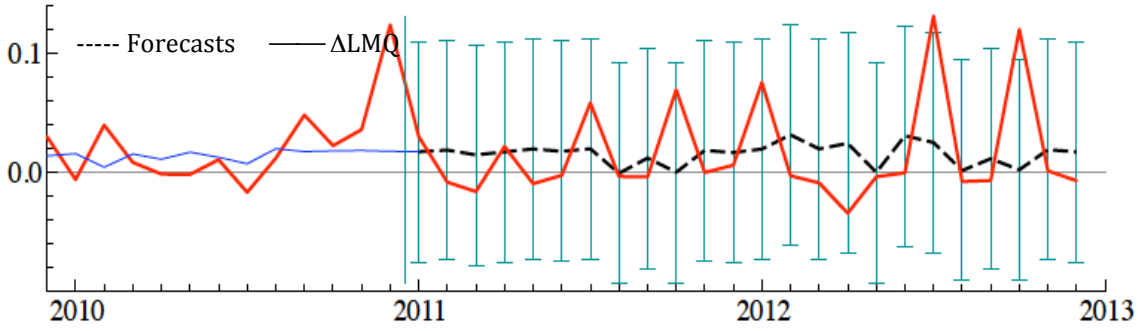


Figure 2: Out-of-sample forecasts for △LMQ equation



5. Conclusion

This paper has investigated whether the money demand function is stable in the case of Laos. From the Johansen cointegration test, the results suggest that there exists a long-run equilibrium among the included variables namely: real narrow (broad) money, real income and interest rate. A restriction test was applied to both the cointegrating and the adjustment vectors. By applying the restriction test to the cointegrating vector, one could test the classical money demand theory by assuming a unit income elasticity of money demand and a zero interest rate semi-elasticity. Results from the tests suggest that the restrictions have to be rejected at a 5 percent significance level for

both narrow and broad money. The results from the restriction on the adjustment vector suggest that:

i. for narrow money, only the income variable is weakly exogenous with respect to the money demand equation and thus, the dynamic system is estimated within a two-equation system namely, the money and the interest rate equations with the corresponding lagged error-correction term of $LM_{t-1} - 0.76LGDP_{t-1} + 0.17INT_{t-1}$ that has a significant loading parameter of -0.07; and
ii. for broad money, the dynamic estimation can be estimated in a one-equation system, which is the money demand equation itself with lagged error-correction term which takes a form $LMQ_{t-1} - 1.54LGDP_{t-1} + 0.33INT_{t-1}$ and has a significant coefficient of -0.007.

All signs are economically intuitive according to the theory and they are significant in the long-run. The income variable has a positive influence on the demand for money and interest rates have a negative influence.

As a result, the long-run equilibrium provides evidence that the money demand function is stable in the case of Laos for the period investigated. Our finding supports Dat et al. (2012) where they also find a stable relationship for the money demand function in Laos with a different specification of explanatory variables than ours other than for real GDP.

For the dynamic estimations, we find that, in the short-run, the dynamic equation for $\triangle$LM (narrow money), the error correction term takes a coefficient of -0.06, suggesting that the tendency to return to the equilibrium after a shock is weak. The net total effect of lagged $\triangle$LM, $\triangle$LGDP and $\triangle$INT exhibit the wrong sign that cannot be interpreted according to the theory. Similar to our results, Dat et al. (2012) also find signs that do not make economic sense for the case of Laos. For example, they find a negative influence of income variable on money growth. However, it is found that only lagged $\triangle INF_{t-2}$ is significant and exhibits the correct sign that can be intuitively explained with a coefficient of -0.37. This suggests that inflation has a strong negative influence on the growth of narrow money. Higher inflation will reduce money demand of Kip. For broad money, the short-run dynamic is represented by equation $\triangle$LMQ. The cointegrating equation has a significant coefficient of -0.003, which is smaller than narrow money, suggesting that the long-run equilibrium is not very influential in determining the short-run dynamic for the growth of broad money. In addition to the cointegrating equation, only $\triangle LGDP_{t-1,}$ $\triangle LGDP_{t-4,}$ $\triangle INT_{t-3}$ are significant in influencing the growth of broad money with coefficients of 0.04, -0.08 and 0.007 respectively. Their coefficients are small in size and only $\triangle LGDP_{t-1}$ is meaningful for economic interpretation. We also find that inflation does not have any influence on the growth of broad money as opposed to what is found in narrow money. This is interesting because the result is contrary to that for a developed country such as Austria in

Hayo (2000). A possible reason for this finding could be due to the fact that time and saving deposits and foreign currency deposits account for a large part of broad money in Laos, and since they are fixed for a certain period of time, it is likely that short-run changes in inflation will have little effect on such holding in the short-run.

This evidence of long-run equilibrium of money demand suggests that the money demand functions are stable for the case of Laos. This arguably supports the central bank in using money supply to control inflation. Out-of-sample forecasts also provide support that the demand functions are stable for both narrow and broad money as the forecasts lie within the confidence intervals with only one exception for narrow money and two for broad money. However, the task of managing price stability is not easy. For further research, it would also be helpful to investigate Laos' inflation dynamics to understand which factors drive inflation. Such an analysis could help the government of Laos and the BoL improve the delivery of monetary policy and their deployment of monetary policy implementation tools to control inflation.

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Section 4

Interest rate pass-through in Laos: Does the interest rate channel work?

Interest rate pass-through in Laos: Does the interest rate channel work?

Vimaly Savannarideth

Philipps University Marburg, Department of Business and Economics, Universitaetsstraße 25, D-35037 Marburg. Email: Savannar@students.uni-marburg.de.

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Abstract. This paper is an empirical investigation of the interest rate pass-through in Lao PDR (Laos). Its aim is to highlight the linkage between policy interest rate and retail interest rates. Our empirical analysis suggests that responses to changes in the policy interest rate are immediate but marginal. Following a one standard deviation innovation in the change in policy rate, deposit rates and lending rates in Kip increase by about 0.1 and 0.2 percentage point respectively. This suggests that the role of monetary policy through the interest rate channel in Laos is limited and not a major one. Furthermore, because Laos allows deposits and lending in US dollar and Baht, it is also important to examine if there is a linkage between the policy interest rates in the United States (U.S.) and in Thailand with the domestic retail interest rates in Laos. Our analysis suggests that Baht deposit rates and US dollar lending rates respond with marginal increase of 0.10 and 0.15 percentage points respectively following a policy change in Thailand and the U.S. This implies that there is only minimal impact from foreign monetary policy shocks to domestic retail interest rates.

JEL Classification: E52; E43

Keywords: Interest rate pass-through, policy rate, retail interest rates, impulse response.

1. Introduction

In many economic environments, where financial markets are sufficiently developed and liquidity is determined through the interest rate channel, the short-term market interest rate becomes the intermediate monetary policy target. In this setting, changes in the short-term interest rate determine other interest rates in the economy, most importantly, banks' retail deposit and lending rates. To have the desired impact on the real economy and inflation, a complete pass-through from policy rate to short-term market rate and then retail interest rates should be realized. Many authors have studied interest rate pass-through, especially in more advanced economies. This topic as mentioned by Kovanen (2011) is also becoming more relevant for developing and emerging markets. However, for the case of developing countries, where financial markets are shallow, transmission through the interest rate channel is likely to be weak and thus the desired effect may not be achieved.

Based on observation, Laos' interest rate channel does appear to be weak. However, the Bank of the Lao PDR (BoL) still chooses to use its policy rate with the expectation of influencing banks' cost of funding and eventually the level of their retail interest rates. The fact that BoL chooses to make use of an interest rate policy suggests that it has confidence in the effect that can be achieved by use of such a policy tool. To the best of our knowledge, hitherto, a detailed study on the interest rate pass-through in Laos has not been undertaken. This paper is a first attempt to address this gap in the literature. The investigation adopted cointegration and impulse response analyses to shed light on the effectiveness of the interest rate pass-through from policy interest rate to the commercial banks' retail interest rates. More precisely speaking, the speed and the size of the adjustment of banks' deposits and lending rates in response to the change in the policy rate using the most recent sample size from 1993-2012 on a monthly basis was be examined. It is hoped that the results support the use of interest rates by the BoL.

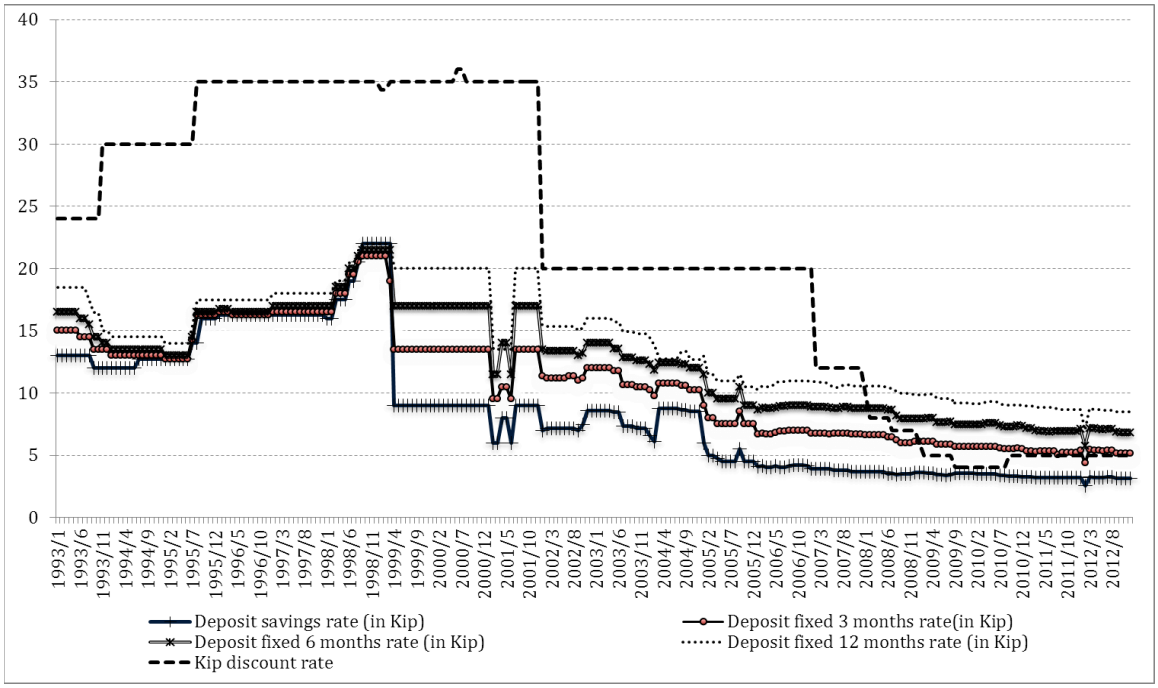
Edwards (2010) suggests that it is also important to understand the extent to which interest rate changes are transmitted across countries because it is particularly important for emerging countries to determine their ability to conduct independent monetary policy. In particular for Laos, where local deposit and lending in foreign currencies, namely US dollar and Baht are allowed, it is expected that there will be a considerable impact of interest rate transmission from the U.S. and Thailand. Therefore, this paper also examines how interest rate changes in the U.S. and Thailand are transmitted to interest rates in Laos for US dollar and Baht denominated deposits.

The remainder of the paper is organized as follows. In section 2, recent developments in the banking sector and interest rate movements in Laos are reviewed. Section 3 reviews the literature regarding interest rates pass-through. This is followed in section 4 by an explanation of the econometric procedures used and the data. Section 5 provides results of the model with section 6 concluding this paper.

2. Recent trends in the banking sector and their interest rates

Like any other central bank, the BoL holds the primary function of managing the country's money supply to make sure that it is in line with economic development fundamentals. The adjustment in the money supply is conducted through monetary tools such as required reserves, interest rate, issuance of term deposits and the purchases of bonds. In the beginning of the 1990s, the banking system comprised four state-owned banks. There was no financial market as such and with a monopoly-like environment, retail interest rates exhibited very little in the way of dynamics. As shown in figure (1) for example, deposit rates in Kip at the beginning of the sample tend to be rigid and are higher compared to the end of the sample. Since the 2000s, there has been an increasing number of banks entering the market. Today, there are a total of 41 banks present in the market. This increase in number and type of banks has helped to develop the banking sector. Developments have included: a greater pool of funds availability, better access to banks and types of service. In addition, there is now a greater level of competition. This increase in competition has driven banks to become more efficient and most importantly, cost effective.

Figure 1: Kip deposit rates

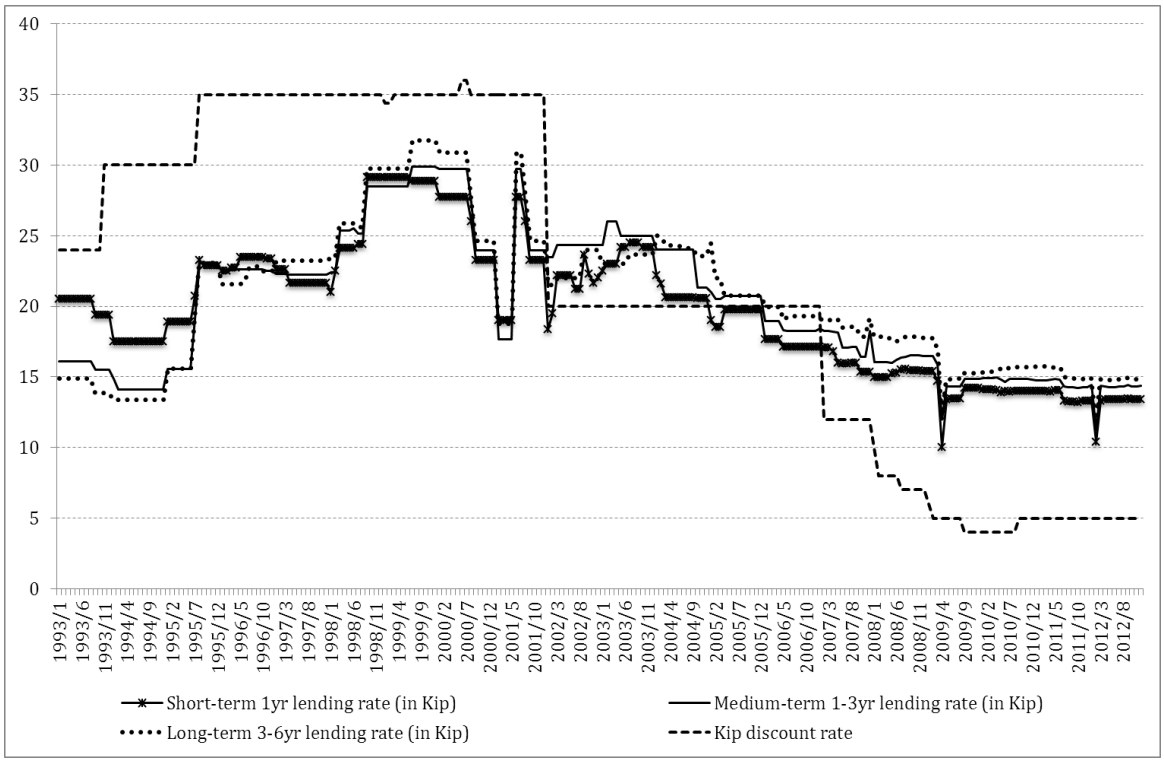


Source: Bank of the Lao PDR

As shown in figures 1 and 2, both deposit and lending rates have a decreasing trend in the later half of the sample especially after year 2000 when increasing numbers of banks commenced business in Laos. We also see that the trend is smoother and reflects more dynamism in the month-to-month

movement. Kip deposit rates start out high in 1993 and end in 2012 at about half that or less than the beginning rate. For instance, the 3 month fixed deposit rate stood at 15 percent at the start of the period and was at 5 percent at the end of 2012. Lending rates start out at roughly 15 percent, increase to about 30 percent during the crisis, and go down to roughly 15 percent in 2012. Thus, except for the period of crisis, lending rates have not changed very much over the period examined. Kip policy rate (discount rate) is also depicted in the figures. Since 2001 the rate has been on a decreasing trend and by the end of 2012, it is parallel to the fixed deposit 3 months rate.

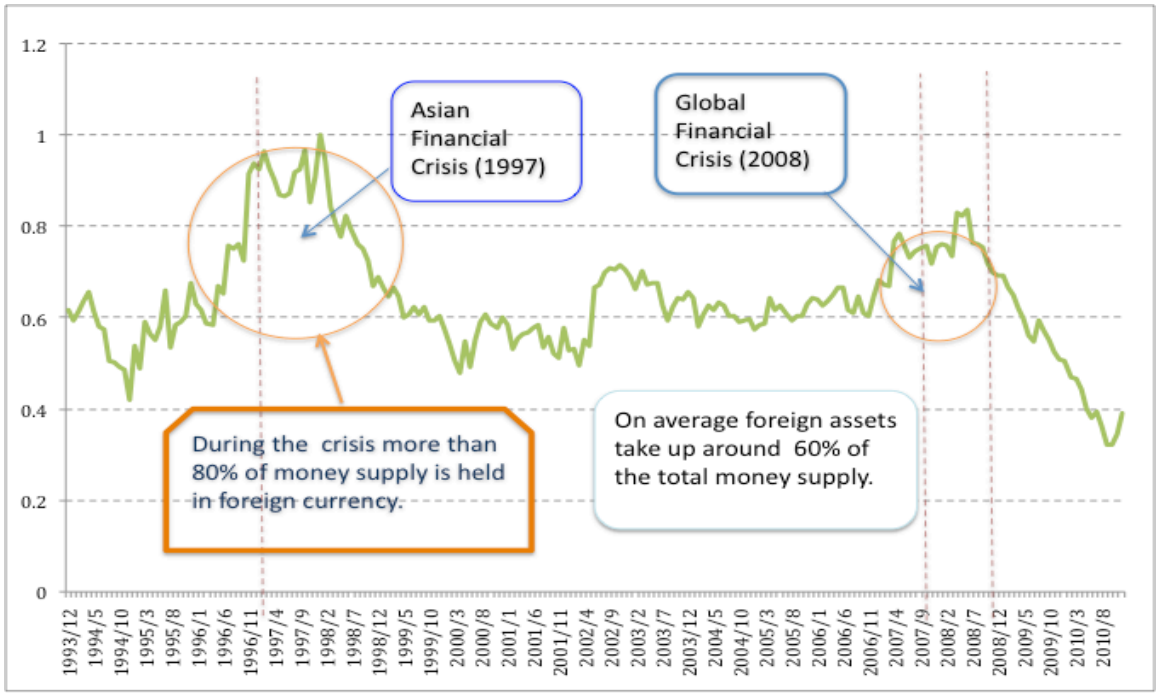
Figure 2: Kip lending rates



Source: Bank of the Lao PDR

As Laos is a dollarized economy, foreign currency holding takes up a large portion of money supply. In figure 3, the ratio of foreign currency holding to broad money from 1993 to 2010 is depicted. It shows that on average, the foreign currency holding is roughly 60 percent (0.6) of broad money. During the Asian financial crisis however, more than 80 percent (0.8) of money supply was held in foreign currency. Since 2008, foreign currency holding has reduced significantly to roughly 40 percent of the money supply.

Figure 3: Ratio of foreign currency holding to broad money



Source: Bank of the Lao PDR

The decreasing foreign asset holding is a signal that the domestic currency is more widely used. However, it is still the case today that Laos holds a large level of foreign currencies and that monetary policy has to take into account this setting. Therefore, it is important in this study to understand how influential foreign monetary shocks are to the domestic foreign interest rates. If it turns out that domestic foreign interest rates react strongly to foreign monetary policy changes, it would imply that the full impact of domestic monetary policy would be hindered. Details of US dollar and Baht retail interest rates can be found in the appendix. In the next section, literature review on interest rate pass-through is reviewed.

3. Literature review

Interest rate pass-through

In countries where interest rate policy is used as an intermediate target to affect the rest of the economy through the interest rate channel, the study of interest pass-through is crucial to monetary conduct. In periods when a contractionary or an expansionary policy should be implemented, it is important to know when and by how much the policy rate should be adjusted to achieve what is initially targeted. Ideally, for an effective pass-through, we expect banks' lending and deposit rates to react in a short period of time to the change in the policy rate. There are many empirical analyses on the interest pass-through. The most relevant are discussed here.

Cottarelli & Kourelis (1994) conducted a study to measure the degree of lending rate stickiness in 31 industrial and developing countries. Using simple dynamic models, they regressed each country's lending rate against lagged money market and discount rates. The degree of stickiness is measured by the response of lending rates following a change in the money market rates at different time lags. They show that in the short-run, the degree of stickiness is different across countries particularly, three and six months after the change in money market rates. In the long-run, for most countries included in the sample, the adjustments are close to unity.

Particularly for the Euro area, De Bondt (2002) examines the retail bank interest rate pass-through and finds that there is an incomplete immediate pass-through of market interest rates to retail bank interest rates. A proportional change in the market rate is passed-through within one month and peaks at around 50 percent. In the long-run, the pass-through is higher, particularly, for bank lending rates which stands close to 100 percent. In addition, he finds that a long-term equilibrium relationship exists between retail bank and market interest rates and that the pass-through has been faster since the introduction of the Euro.

Borio & Fritz (1995) argue that bank lending rate is a good indicator of the marginal cost of short-term external funding. This marginal cost is viewed as the average cost of borrowing or the opportunity cost that banks use to make cash flow decisions. Through this opportunity cost, monetary policy is transmitted to the rest of the economy. Their findings show that different countries respond differently to the change in policy and market rates. In several countries, the adjustment path is unchanged. For the U.K. the adjustment is immediate both in the short and the long run. The U.S., Canada, and Netherlands show similar adjustment speed in the short run while in Denmark and Italy very little change is found. Rocha (2012)'s investigation also shows that monetary policy action is slowly transmitted through lending rates and that monetary policy has stronger effects on the cost of finance than the return on savings.

De Bondt (2005) empirically investigates the pass-through from official interest rates to retail bank interest rates. He uses overnight to long-run market interest rates as a proxy for official interest rates or as the marginal costs for banks to attract deposits or give loans. Adopting error-correction and vector autoregressive model, he finds that the pass-through of official interest rates to market interest rates is complete for money market interest rates up to three months, but not for those with longer maturities. In addition, he discovers that the immediate pass-through of changes in the market interest rates to bank deposit and lending rates are at most 50 percent and the final pass-through is found to be close to 100 percent, particularly, in the lending rates. These results are similar to the finding in De Bondt (2002).

More relevant to Laos is the study on Ghana as it has a similar economic environment. For Ghana, Kovanen (2011) shows that only half of the change in the policy rates is reflected in the wholesale market interest rates (interbank and treasury bill) with a one month lag. In the long-run, the impact fades. The banks' retail interest rates adjust to changes in the wholesale market interest rates, but the speed is rather slow and the adjustment is incomplete in the long-run.

The studies that we have discussed above, show that the responses of the interest rate pass-through vary from one country to another and the responsiveness of interest rate pass-through depends on many factors. Cottarelli & Kourelis (1994) suggest five structural factors that are relevant in reducing lending rate stickiness. These factors are: the existence of a sizable market for short-term monetary instruments (such as certificates of deposits or treasury bills), the absence of constraints on capital movements, the absence of constraints on bank competition, private sector ownership of the banking sector and the containment of the random component of money market rates. Moazzami (1999) argues that barriers to entry decrease the responsiveness of interest rate pass-through in the long-run as in the case of Canada. Kovanen (2011) argues that the slow adjustment behavior of the retail interest rates has to do with other factors such as the uncertainty about the future course of macroeconomic policies coupled with high levels of problem loans. Olivero, Li, & Jeon (2011) investigate the impact of bank consolidation on interest rate pass-through. Their results show that monetary policy becomes less effective as concentration in the banking sector increases evidence from across Asia and Latin America. In particular, the smaller the size of the financial sector, the more adverse the effect banking consolidation has. A recent study by Saborowski & Weber (2013) sets out to identify the determinants of interest rate transmission for both advanced and less developed countries from 2000 to 2011. They find that exchange rate flexibility, banking sector concentration, liquidity ratio, non performing loans ratios (NPLs) and financial dollarization are important determinants of pass-through. They find that by moving from a pegged to a floating exchange rate regime, an improvement from 25 to 50 percentage points of pass-through is found. For banking sector concentration and liquidity ratio, an increase from the 20th to the 80th percentile is associated with a fall in the pass-through of around 20 percentage points. A decrease in the share of the NPLs in total loans from the 80th to 20th percentile is associated with an increase in pass-through of between 10-20 percentage points. When the share of foreign currency loans in total loans drop from the 80th to the 20th percentile, it improves the pass-through by about the same magnitude. Importantly, the pass-through in developing countries is significantly lower at around 30-45 percent than that of developed countries.

<u>The transmission of interest rate pass-through across countries</u>

Studying the interest rate pass-through is necessary to assist the monetary authority in its understanding of the monetary policy transmission mechanism. In addition, given the connectedness

between countries for many countries, it is also important to be aware of the pass-through of changes in policy rates in other monetary areas, e.g., the U.S. Just as the changes in business cycle of one country may influence the business cycle of other countries. In a similar way, a change in monetary policy in one country may affect other countries' monetary stance. Edwards (2010) proposes that it is important to understand the extent to which interest rate changes are transmitted across countries. This understanding is particularly relevant for emerging countries to help them to determine their ability to conduct independent monetary policy. Among others, authors that have conducted studies on the impact of monetary shocks across countries include: Hausmann, Gavin, Pages, & Stein (1999), Frankel, Schmukler, & Servén (2004) and Philippon, Zettelmeyer, & Borensztein (2001).

Hausmann, Gavin, Pages, & Stein (1999), for example, conduct an investigation among Latin American countries namely Argentina, Brazil, Chile, Colombia and Mexico. They set out to determine whether exchange rate regime arrangement could provide some cushion to external shocks. Using monthly data from 1960 to 1998, they find no evidence that floating arrangements insulate domestic interest rates from the influence of foreign rate movements.

Frankel, Schmukler, & Servén (2004) conduct a large sample analysis on the global transmission of interest rates for developing and industrialized economies from 1970 to 1999. Their results show that we cannot reject full transmission of international interest rates in the long run, even for countries with floating regimes except some large industrial countries. In the short-run, the effects do differ across regimes. Their dynamic estimations show that interest rates of countries with more flexible regimes adjust more slowly to changes in international rates. This implies that in those countries with a flexible exchange rate regime, central banks do have some control over monetary independence.

Similar to the results of Frankel, Schmukler, & Servén (2004), Shambaugh (2004) using 155 countries from 1973 to 2000 examines how domestic interest rate in fixed and floating exchange rate regimes respond differently to changes in foreign interest rate shocks. In brief, his results show that countries under fixed exchange rates are likely to follow the monetary policy movement of the base country more closely than those under a floating rate regime. Furthermore, he shows that the interest rates of pegged countries react more quickly to changes in the base interest rates than those of non-pegged countries. In addition, he points out that in the short-run, countries with a more flexible exchange rate regime tend to have more autonomy than those with a fixed exchange rate but not necessarily in the long-run.

Frankel, Schmukler, & Servén (2004) and Shambaugh (2004) each have results that suggest that different exchange rate regimes matter for interest rate pass-through across countries especially if

we distinguish between short and long-run. Furthermore, Miniane & Rogers (2007) try to assess whether in addition to the difference in exchange rate regime, capital controls plays any significant role. Miniane & Rogers (2007) in their paper assess whether capital control could effectively insulate countries from U.S. monetary shocks for 26 countries covering a range of the countries' characteristics such as: capital account restriction, economic development, geographic location, and exchange rate regime. They find no evidence that high capital controls result in a smaller interest rate response.

A more recent study by Edwards (2010), investigates how changes in interest rates by the Federal Reserve (Fed) affected interest rate differentials in Brazil, Chile, Colombia, Mexico, Indonesia, Korea, Malaysia and the Philippines. In addition, he also studies how changes in the advanced countries term structure of interest rates affect financial conditions in the emerging nations. His results show that in the Latin American countries, an increase in the Fed's policy rate by 50 basis points results in an immediate decline in the unadjusted interest rate differential of 30 basis points. For Asian countries in the sample, the impact of the Fed's policy rate is smaller with only 16 basis points reduction to the unadjusted interest rate differential. He concludes that a Federal Reserve action has a significant impact on interest rates in emerging markets even if the exchange rate and country risk channels are controlled for. This provides further support for the perspective of Frankel, Schmukler, & Servén's (2004) that emerging countries with flexible exchange rates do not have full control over monetary policy in the short run.

Many empirical studies on interest rate pass-through are available for more advanced countries namely: the U.S., the U.K., Canada, Europe, some Latin American countries, and a few Asian countries. To our knowledge, there is no study on interest rate pass-through in Laos. This analysis investigated two aspects of interest rate pass-through: i) to understand how banks' deposits and lending rates respond to changes in the policy rate (BOL's discount rate), and ii) to investigate how domestic foreign currency account interest rates respond to changes in foreign policy rates. We use the discount rates of the Fed and the Bank of Thailand as proxies for foreign currency policy rates. In the next section, the source data and analysis methodology will be explained in detail.

4. Data and methodology

The data set covers the period from 1993 to 2012 on a monthly basis. Data was sourced from the BoL and from Allthatstat.com. The original source for our data from Allthatstat.com is the International Monetary Fund (IMF). There are a total of 4 different types of retail deposit rates and 3 different types of lending rates being examined in this study. Each deposit and lending rate type is denominated in Kip, Baht and US dollar. Variables used in the study are listed as below.

Banks' retail deposit rates

(1) Deposit fixed 12 months rate

(2) Deposit fixed 6 months rate

(3) Deposit fixed 3 months rate

(4) Deposit saving rate: deposit rate without duration, withdrawal is allowed anytime.

Banks' retail lending rates

(5) Long-term 3-6yr lending rate

(6) Medium-term 1-3yr lending rate

(7) Short-term 1yr lending rate

Policy rates and inflation

(8) Kip discount rate: is the short-term lending interest rate of BoL at which BoL lends commercial banks with insufficient liquidity at the end of the period for the reserve requirement (as defined by the BoL).

(9) Baht discount rate: refers to interest rate charged on loans made to financial institutions under security repurchase agreement for bridging the end-of-day liquidity gap (as defined by the Bank of Thailand).

(10) US dollar discount rate: is the interest rate charged to commercial banks and other depository institutions on loans they receive from their regional Federal Reserve Bank's lending facility – the discount window (as defined by the Board of Governors of the Federal Reserve System).

(11) Inflation rate: is the inflation rate of Laos.

Seasonality, Unit Root and Cointegration Test

Using X-12 ARIMA, we ran seasonality tests on all the variables. Seasonality was not detected. Details of the seasonality tests can be provided on request. Following the seasonality test, we used the Augmented Dickey-Fuller (ADF) test to check for stationarity of the variables. The results of the ADF tests are shown in tables (1) and (2), which suggest that the variables are integrated of order one (I(1)). Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) unit root tests also gave similar results. The results from the KPSS tests are provided in table (3).

Table 1. Augmented Dickey-Fuller test

ADF test	with constant	with constant and linear trend	without constant or linear trend
Test at log-level	ADF statistic	ADF statistic	ADF statistic
Deposit fixed 12mth (in Baht)	-1.47	-0.98	-1.54
Deposit fixed 24mth (in Baht)	-3.50*	-3.32	-2.30*
Deposit fixed 3mth (in Baht)	-2.03	-1.46	-2.26*
Deposit fixed 6mth (in Baht)	-1.99	-1.25	-2.20*
Deposit saving (in Baht)	-1.98	-1.80	-2.20*
Deposit fixed 12mth (in Kip)	-0.68	-1.61	-1.47
Deposit fixed 24mth (in Kip)	-1.31	-2.20	-1.48
Deposit fixed 3mth (in Kip)	-0.95	-2.47	-1.27
Deposit fixed 6mth (in Kip)	-1.21	-2.64	-1.18
Deposit saving (in Kip)	-1.40	-2.85	-1.27
Deposit fixed 12mth (in USD)	-2.02	-1.70	-1.30
Deposit fixed 24mth (in USD)	-1.82	-1.60	-1.05
Deposit fixed 3mth (in USD)	-1.77	-1.41	-1.28
Deposit fixed 6mth (in USD)	-1.94	-1.51	-1.33
Deposit saving (in USD)	-2.15	-2.44	-1.50
Kip discount rate	-0.19	-2.78	-0.97
Baht discount rate	-1.45	-1.45	-1.68
USD discount rate	-1.81	-2.60	-1.13
Long-term 3to6yr (in Baht)	-3.19*	-3.73	-0.93
Medium-term 1to3yr (in Baht)	-1.97	-4.09	-0.70
Short-term 1yr (in Baht)	-1.83	-5.24	-1.21
Long-term 3to6yr (in Kip)	-1.90	-2.30	-0.46
Medium-term 1to3yr (in Kip)	-1.77	-2.30	-0.51
Short-term 1yr (in Kip)	-1.53	-2.51	-0.76
Long-term 3to6yr (in USD)	-2.72	-2.70	-0.33
Medium-term 1to3yr (in USD)	-3.32*	-3.28	-0.36
Short-term 1yr (in USD)	-4.10*	-4.36	-0.27
Inflation	-2.03	-2.42	-1.59

Automatic lag selection base on Schwarz information criterion with maximum lag=13. Null hypothesis: Variable has a unit root. One asterisk indicates a rejection of the Null at 5 percent significance level.

Table 2. Augmented Dickey-Fuller test

ADF test	with constant	with constant and linear trend	without constant or linear trend
Test at first difference	ADF statistic	ADF statistic	ADF statistic
Deposit fixed 12mth (in Baht)	-15.16*	-15.20*	-15.14*
Deposit fixed 24mth (in Baht)	-11.67*	-12.10*	-11.64*
Deposit fixed 3mth (in Baht)	-15.79*	-15.91*	-15.71*
Deposit fixed 6mth (in Baht)	-15.54*	-15.67*	-15.46*
Deposit saving (in Baht)	-13.89*	-13.94*	-13.84*
Deposit fixed 12mth (in Kip)	-9.68*	-9.67*	-9.58*
Deposit fixed 24mth (in Kip)	-13.43*	-13.41*	-13.37*
Deposit fixed 3mth (in Kip)	-13.99*	-13.97*	-13.97*
Deposit fixed 6mth (in Kip)	-16.89*	-16.86*	-16.87*
Deposit saving (in Kip)	-15.62*	-15.59*	-15.62*
Deposit fixed 12mth (in USD)	-15.86*	-15.91*	-15.87*
Deposit fixed 24mth (in USD)	-13.75*	-13.94*	-13.77*
Deposit fixed 3mth (in USD)	-15.61*	-15.66*	-15.63*

Deposit fixed 6mth (in USD)	-16.24*	-16.32*	-16.25*
Deposit saving (in USD)	-12.47*	-12.46*	-12.48*
Kip discount rate	-15.22*	-15.30*	-15.18*
Baht discount rate	-14.03*	-14.02*	-13.99*
USD discount rate	-4.89*	-4.93*	-4.89*
Long-term 3to6yr (in Baht)	-16.31*	-16.27*	-16.34*
Medium-term 1to3yr (in Baht)	-11.69*	-11.67*	-11.71*
Short-term 1yr (in Baht)	11.96*	-11.94*	-11.94*
Long-term 3to6yr (in Kip)	-15.02*	-15.06*	-15.06*
Medium-term 1to3yr (in Kip)	-14.94*	-10.68*	-14.97*
Short-term 1yr (in Kip)	-15.80*	-15.79*	-15.83*
Long-term 3to6yr (in USD)	-17.22*	-17.21*	-17.26*
Medium-term 1to3yr (in USD)	-17.47*	-17.45*	-17.50*
Short-term 1yr (in USD)	-11.13*	-11.12*	-11.15*
Inflation	-6.41*	-6.42*	-6.43*

Automatic lag selection base on Schwarz information criterion with maximum lag=13. Null hypothesis: Variable has a unit root. One asterisk indicates a rejection of the Null at 5 percent significance level.

Table 3. Kwiatkowski-Phillips-Schmidt-Shin test

	Test at level		Test at first difference of level	
KPSS test	with constant	with constant and linear trend	with constant	with constant and linear trend
	KPSS statistic	KPSS statistic	KPSS statistic	KPSS statistic
Deposit fixed 12mth (in Baht)	1.36*	0.45*	0.23	0.09
Deposit fixed 24mth (in Baht)	0.36	0.36*	0.66*	0.11
Deposit fixed 3mth (in Baht)	1.52*	0.47*	0.28	0.04
Deposit fixed 6mth (in Baht)	1.45*	0.48*	0.32	0.05
Deposit saving (in Baht)	1.67*	0.40*	0.17	0.03
Deposit fixed 12mth (in Kip)	1.63*	0.30*	0.05	0.04
Deposit fixed 24mth (in Kip)	1.40*	0.29*	0.09	0.06
Deposit fixed 3mth (in Kip)	1.81*	0.21*	0.05	0.05
Deposit fixed 6mth (in Kip)	1.72*	0.29*	0.06	0.05
Deposit saving (in Kip)	1.71*	0.14*	0.05	0.05
Deposit fixed 12mth (in USD)	1.05*	0.35*	0.18	0.04
Deposit fixed 24mth (in USD)	0.36	0.34*	0.07	0.07
Deposit fixed 3mth (in USD)	1.13*	0.30*	0.18	0.07
Deposit fixed 6mth (in USD)	1.10*	0.35*	0.23	0.06
Deposit saving (in USD)	1.25*	0.27*	0.06	0.04
Kip discount rate	1.63*	0.32*	0.29	0.11
Baht discount rate	1.28*	0.20*	0.09	0.06
USD discount rate	0.67*	0.12*	0.12	0.06
Long-term 3to6yr (in Baht)	0.84*	0.11*	0.05	0.05
Medium-term 1to3yr (in Baht)	1.13*	0.15*	0.21	0.21
Short-term 1yr (in Baht)	1.18*	0.08*	0.37	0.35
Long-term 3to6yr (in Kip)	0.61*	0.39*	0.27	0.09
Medium-term 1to3yr (in Kip)	0.74*	0.41*	0.29	0.11
Short-term 1yr (in Kip)	1.23*	0.37*	0.14	0.06
Long-term 3to6yr (in USD)	0.17	0.19*	0.11	0.06
Medium-term 1to3yr (in USD)	0.24	0.24*	0.14	0.07
Short-term 1yr (in USD)	0.43	0.17*	0.21	0.17
Inflation	0.39	0.13*	0.06	0.04

Spectral estimation method: Bartlett Kernel, Bandwidth: (Newey-west using Bartlett Kernel). Null hypothesis: Variable is stationary. One asterisk indicates a rejection of the Null at 5 percent significance level.

We adopted the Johansen cointegration test to identify long-run equilibria among the I(1) variables. The test was conducted in a VAR framework. The number of lags to include in the VAR was based on the respective information criteria. With the appropriate number of lags selected a Johansen cointegration test was then performed.

The following steps were used to identify whether there are cointegrating vector(s) among our variables that is/are significant and economically intuitive.

(i) Starting with bivariate VAR systems, we tested whether the relevant central bank discount rate has a long-run relationship with each of the relevant Lao commercial bank deposit and lending rates or not. This was done for each currency (Kip, Baht, US dollar) with the corresponding discount rates in Kip, Baht and US dollar. The test was performed in a VAR framework starting with 12 lags. Two specifications of the cointegrating vector tests were examined; one with a constant and the other without. Each lag length was checked to see if a significant cointegrating vector exists. If a significant cointegrating vector was found, the cointegrating and the adjustment vectors were checked for their significance and whether their signs make economic sense. We found no long-run cointegrating vectors that are satisfactory in term of the significance level and the expected signs.

(ii) As we found no satisfactory cointegrating vectors, we investigated to see if there could possibly be any inflation effect based on Irving Fisher's Theory. So, inflation was added to the bivariate VAR systems and the same testing procedures were used. The results also found no satisfactory long-run cointegrating vectors.

(iii) The cointegration test can be sensitive to the number of variables included in the system as well as to the different specifications employed for the test. Therefore, we carefully investigated several other possibilities by adding more variables into the VAR framework. The VAR models were re-specified to contain 3 variables, which are: one discount rate and either two deposits or two lending rates under different alternative combinations. VARs containing a discount rate, one deposit rate and one lending rate were also examined. Under these alternative VAR frameworks we also found no satisfactory cointegrating vectors.

(iv) Once again, the inflation rate was included into each of the multivariate VARs. As previously, we found no satisfactory cointegrations.

(v) Lastly, cointegration tests for a maximum of 4 variables were performed for each currency. The VAR was constructed so that we have the discount rate, deposit fixed 12 months rate, deposit fixed 6 months rate, deposit fixed 3 months rate (or deposit saving rate). For lending

rates, the discount rate and all the lending rates were included in the system. The results again, indicated that there were no satisfactory long-run cointegrating vectors.

Impulse response analysis

Given that we found no satisfactory cointegrating vectors, we estimated the VAR system in first differences and then derived impulse response functions (Lütkepohl & Breitung (1996)). In general, the residuals of a VAR are a mixture of shocks of all variables in the system and cannot be used for the purpose of assessing the specific effects of policy shocks. In order to modify the model to be able to identify the shocks of interest, Cholesky-decomposition was used. Cholesky-decomposition assumes a recursive structure of the system of structural equations so that we can study the impact of an innovation in one of the variables on another over time.

The final model specification selected for estimating the impulse response functions were: (i) discount rate, deposit fixed 12 months rate, deposit fixed 6 months rate, deposit fixed 3 months rate, and (ii) discount rate, long-term 3-6yr lending rate, medium-term 1-3yr lending rate, short-term 1yr lending rate. The specification was applied to Kip, Baht and US dollar. As explained by Favero (1999), the VAR approach to the monetary transmission mechanism can be used to study the information in the responses of macroeconomic variables to a deviation in monetary policy impulses. Hence, the discount rate is put first, followed by the interest rates ordered from the longest term to the shortest horizon. For example, in the case of lending rates analysis, we assume that contemporaneously the discount rate is affected only by its own shock; the long-term lending rate is affected by its own shock and the shock of the discount rate; the medium-term lending rate is affected by its own shock, the shock of long-term lending rate and the shock of the discount rate; and finally, the short-term lending rate is affected by its own shock, the shock from medium-term rate, the shock from long-term rate and the shock from discount rate. In this way, we ensured that the monetary policy shock was pure and can be interpreted appropriately for the purpose of our study.

Starting with maximum lag length of 12, the variables were formed into a VAR framework and estimated. Then, each estimated lag VAR system starting from 12 down to lag 1 were compared using various information criteria namely: the Log likelihood ratio (LR) test, Akaike information criterion (AIC), Schwarz information criterion (SC) and Hanna Quinn information criterion (HQ) to identify the appropriate lag length. However, there is a danger that the underlying dynamics are too restricted when using a very short lag length, therefore, when longer lag lengths were suggested by the information criteria, they were preferred over the shorter lag lengths. In addition, the optimal lag length that is identified should also maintain satisfactory statistical properties, most importantly, that the VAR residuals are not autocorrelated. Once the optimal lag was identified and the statistical properties were satisfied, the impulse responses were generated.

The lag length selected for the final models for Kip deposit rates was lag 7, for Kip lending rates was lag 7, for Baht deposit rates was lag 12, for Baht lending rate was lag 7, for US dollar deposit rates was lag 12 and for US dollar lending rates was lag 12. Details of their statistical tests results are shown in table (4). The next section discusses the results of the impulse response functions.

Table 4: Statistical properties of the VAR models

VAR for Kip deposit rates (in first difference) Lag 7	VAR for Kip lending rates (in first difference) Lag 7
Included variables: Kip discount rate, deposit fixed 12 months rate, deposit fixed 6 months rate, deposit fixed 3 months rate	Included variables: Kip discount rate, Long-term 3to6yr lending rate, Medium-term 1to3yr lending rate, Short-term 1yr lending rate
Single-equation diagnostics using reduced-form residuals:	Single-equation diagnostics using reduced-form residuals:
Kip discount rate : AR 1-1 test: F(1,202) = 1.6527 [0.2001]	Kip discount rate : AR 1-1 test: F(1,202) = 0.41118 [0.5221]
Kip discount rate : Normality test: Chi^2(2) = 558.94 [0.0000]**	Kip discount rate : Normality test: Chi^2(2) = 482.91 [0.0000]**
Kip discount rate : Hetero test: F(56,175) = 0.81620 [0.8103]	Kip discount rate : Hetero test: F(56,175) = 1.7270 [0.0039]**
Deposit fixed 12 months rate : AR 1-1 test: F(1,202) = 3.2696 [0.0721]	Long-term 3to6yr lending rate : AR 1-1 test: F(1,202) =0.00085585 [0.9767]
Deposit fixed 12 months rate : Normality test: Chi^2(2) = 262.67 [0.0000]**	Long-term 3to6yr lending rate : Normality test: Chi^2(2) = 238.34 [0.0000]**
Deposit fixed 12 months rate : Hetero test: F(56,175) = 0.045040 [1.0000]	Long-term 3to6yr lending rate : Hetero test: F(56,175) = 2.7428 [0.0000]**
Deposit fixed 6 months rate : AR 1-1 test: F(1,202) = 4.0312 [0.0460]*	Medium-term 1to3yr lending rate : AR 1-1 test: F(1,202) =0.0010020 [0.9748]
Deposit fixed 6 months rate : Normality test: Chi^2(2) = 158.22 [0.0000]**	Medium-term 1to3yr lending rate : Normality test: Chi^2(2) = 220.24 [0.0000]**
Deposit fixed 6 months rate : Hetero test: F(56,175) = 0.11180 [1.0000]	Medium-term 1to3yr lending rate : Hetero test: F(56,175) = 2.6748 [0.0000]**
Deposit fixed 3 months rate : AR 1-1 test: F(1,202) = 0.90526 [0.3425]	Short-term 1yr lending rate : AR 1-1 test: F(1,202) = 0.80703 [0.3701]
Deposit fixed 3 months rate : Normality test: Chi^2(2) = 156.70 [0.0000]**	Short-term 1yr lending rate : Normality test: Chi^2(2) = 319.28 [0.0000]**
Deposit fixed 3 months rate : Hetero test: F(56,175) = 0.48404 [0.9990]	Short-term 1yr lending rate : Hetero test: F(56,175) = 2.1362 [0.0001]**
Vector AR 1-1 test: F(16,599)= 1.2173 [0.2489]	Vector AR 1-1 test: F(16,599)= 1.5330 [0.0828]
Vector Normality test: Chi^2(8) = 1139.0 [0.0000]**	Vector Normality test: Chi^2(8) = 1213.4 [0.0000]**
Vector ZHetero test: F(224,689)= 1.8344 [0.0000]**	Vector ZHetero test: F(224,689)= 1.1667 [0.0731]
VAR for Baht deposit rates (in first difference) Lag 12	VAR for Baht lending rates (in first difference) Lag 7
Included variables: Baht discount rate, deposit fixed 12 months rate, deposit fixed 6 months rate, deposit fixed 3 months rate	Included variables: Baht discount rate, Long-term 3to6yr lending rate, Medium-term 1to3yr lending rate, Short-term 1yr lending rate
Single-equation diagnostics using reduced-form residuals:	Single-equation diagnostics using reduced-form residuals:
Baht discount rate : AR 1-1 test: F(1,177) = 0.13441 [0.7143]	Baht discount rate : AR 1-1 test: F(1,202) =3.9437e-005 [0.9950]
Baht discount rate : Normality test: Chi^2(2) = 90.462 [0.0000]**	Baht discount rate : Normality test: Chi^2(2) = 3383.5 [0.0000]**
Baht discount rate : Hetero test: F(96,130) = 14.183 [0.0000]**	Baht discount rate : Hetero test: F(56,175) = 0.089110 [1.0000]
Deposit fixed 12 months rate : AR 1-1 test: F(1,177) = 0.72260 [0.3964]	Long-term 3to6yr lending rate : AR 1-1 test: F(1,202) = 0.25291 [0.6156]
Deposit fixed 12 months rate : Normality test: Chi^2(2) = 196.49 [0.0000]**	Long-term 3to6yr lending rate : Normality test: Chi^2(2) = 331.11 [0.0000]**
Deposit fixed 12 months rate : Hetero test: F(96,130) = 1.6355 [0.0046]**	Long-term 3to6yr lending rate : Hetero test: F(56,175) = 2.1405 [0.0001]**
Deposit fixed 6 months rate : AR 1-1 test: F(1,177) = 0.032286 [0.8576]	Medium-term 1to3yr lending rate : AR 1-1 test: F(1,202) = 0.83364 [0.3623]
Deposit fixed 6 months rate : Normality test: Chi^2(2) = 432.86 [0.0000]**	Medium-term 1to3yr lending rate : Normality test: Chi^2(2) = 540.89 [0.0000]**
Deposit fixed 6 months rate : Hetero test: F(96,130) = 3.0765 [0.0000]**	Medium-term 1to3yr lending rate : Hetero test: F(56,175) = 2.8832 [0.0000]**
Deposit fixed 3 months rate : AR 1-1 test: F(1,177) = 0.010368 [0.9190]	Short-term 1yr lending rate : AR 1-1 test: F(1,202) = 0.11871 [0.7308]
Deposit fixed 3 months rate : Normality test: Chi^2(2) = 351.70 [0.0000]**	Short-term 1yr lending rate : Normality test: Chi^2(2) = 761.93 [0.0000]**
Deposit fixed 3 months rate : Hetero test: F(96,130) = 3.4155 [0.0000]**	Short-term 1yr lending rate : Hetero test: F(56,175) = 3.0514 [0.0000]**
Vector AR 1-1 test: F(16,523)= 0.7681 [0.7224]	Vector AR 1-1 test: F(16,599)= 0.50130 [0.9471]
Vector Normality test: Chi^2(8) = 648.71 [0.0000]**	Vector Normality test: Chi^2(8) = 4180.9 [0.0000]**
Vector ZHetero test: F(384,510)= 3.8285 [0.0000]**	Vector ZHetero test: F(224,689)= 0.83451 [0.9471]
VAR for USD deposit rates (in first difference) Lag 12	VAR for USD lending rates (in first difference) Lag 12
Included variables: USD discount rate, deposit fixed 12 months rate, deposit fixed 6 months rate, deposit fixed 3 months rate	Included variables: Baht discount rate, Long-term 3to6yr lending rate, Medium-term 1to3yr lending rate, Short-term 1yr lending rate
Single-equation diagnostics using reduced-form residuals:	Single-equation diagnostics using reduced-form residuals:
USD discount rate : AR 1-1 test: F(1,177) = 0.012715 [0.9103]	USD discount rate : AR 1-1 test: F(1,177) = 1.3414 [0.2483]
USD discount rate : Normality test: Chi^2(2) = 375.67 [0.0000]**	USD discount rate : Normality test: Chi^2(2) = 92.837 [0.0000]**
USD discount rate : Hetero test: F(96,130) = 1.1113 [0.2863]	USD discount rate : Hetero test: F(96,130) = 2.2251 [0.0000]**
Deposit fixed 12 months rate : AR 1-1 test: F(1,177) = 0.10545 [0.7458]	Long-term 3to6yr lending rate : AR 1-1 test: F(1,177) = 0.041194 [0.8394]
Deposit fixed 12 months rate : Normality test: Chi^2(2) = 433.12 [0.0000]**	Long-term 3to6yr lending rate : Normality test: Chi^2(2) = 233.14 [0.0000]**
Deposit fixed 12 months rate : Hetero test: F(96,130) = 1.6949 [0.0026]**	Long-term 3to6yr lending rate : Hetero test: F(96,130) = 1.1511 [0.2267]
Deposit fixed 6 months rate : AR 1-1 test: F(1,177) = 0.030207 [0.8622]	Medium-term 1to3yr lending rate : AR 1-1 test: F(1,177) = 4.0196 [0.0465]*
Deposit fixed 6 months rate : Normality test: Chi^2(2) = 434.77 [0.0000]**	Medium-term 1to3yr lending rate: Normality test: Chi^2(2) = 244.01 [0.0000]**
Deposit fixed 6 months rate : Hetero test: F(96,130) = 0.83068 [0.8309]	Medium-term 1to3yr lending rate: Hetero test: F(96,130) = 1.5071 [0.0148]*
Deposit fixed 3 months rate: AR 1-1 test: F(1,177) = 0.39001 [0.5331]	Short-term 1yr lending rate: AR 1-1 test: F(1,177) = 5.0269 [0.0262]*
Deposit fixed 3 months rate: Normality test: Chi^2(2) = 250.30 [0.0000]**	Short-term 1yr lending rate: Normality test: Chi^2(2) = 388.35 [0.0000]**
Deposit fixed 3 months rate: Hetero test: F(96,130) = 0.11678 [1.0000]	Short-term 1yr lending rate: Hetero test: F(96,130) = 1.7304 [0.0018]**
Vector AR 1-1 test: F(16,523)= 0.9750 [0.4828]	Vector AR 1-1 test: F(16,523)= 1.6506 [0.0526]
Vector Normality test: Chi^2(8) = 1055.0 [0.0000]**	Vector Normality test: Chi^2(8) = 476.60 [0.0000]**
Vector ZHetero test: F(384,510)= 1.2162 [0.0197]*	Vector ZHetero test: F(384,510)= 1.2241 [0.0167]*

5. Results from impulse responses

Figure (4) shows impulse responses of Kip deposit rates to Kip discount rate. It suggests that following a one standard deviation innovation, approximately a change of one percentage point in the Kip discount rate, leads to a statistically significant increase of 0.1 percentage point in all deposit rates, namely: the 12 months, 6 months and 3 months fixed deposit rates but the significance level drops to zero after two months. In the case of lending rates as shown in figure (5), the responses of all the lending rates are significant and increase by 0.2 percentage points. In both deposit and lending rates, the responses are only significant in the first month and then they fall to zero.

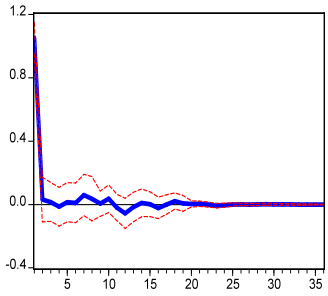
The impulse responses as shown in figure (6) suggest that following a policy shock in Thailand, deposit rates in Baht in Laos respond significantly with an increase of about 0.1 percentage point in the 2nd month and then fall to zero by the 4th month. For Baht lending rates in Laos, we find no significant response to changes in the lending rates due to the Thai policy rate as shown in figure (7).

US dollar retail rates responses are depicted in figures (8) and (9). We find that the impulse responses of deposit rates in US dollars are not significant following the shock. On the other hand, the responses in the lending rates are significant; all lending rates increase in the first month by 0.15 percentage points and then fall to zero.

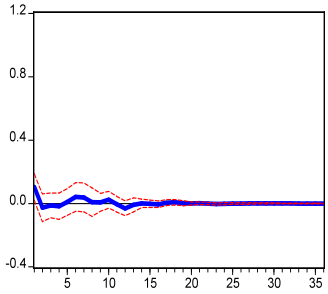
Figure 4: Impulse responses of deposit rates (in Kip) to Kip discount rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

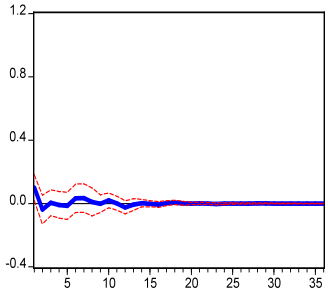
Response of Kip discount rate to Kip discount rate



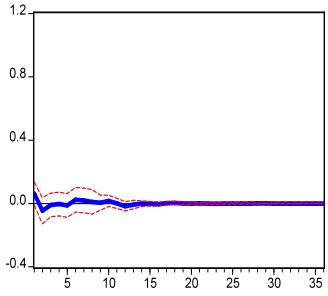
Response of Deposit fixed 12 months rate to Kip discount rate



Response of Deposit fixed 6 months rate to Kip discount rate

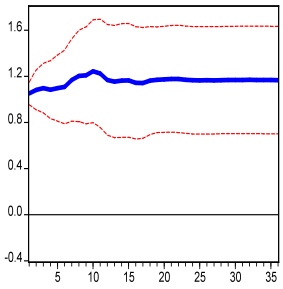


Response of Deposit fixed 3 months rate to Kip discount rate

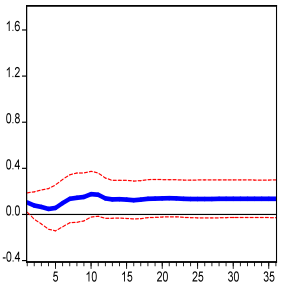


Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

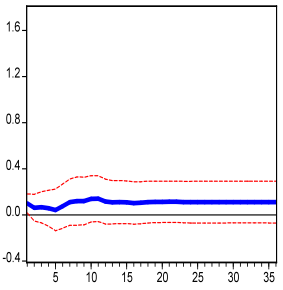
Accumulated Response of Kip discount rate to Kip discount rate



Accumulated Response of Deposit fixed 12 months rate to Kip discount rate



Accumulated Response of Deposit fixed 6 months rate to Kip discount rate



Accumulated Response of Deposit fixed 3 months rate to Kip discount rate

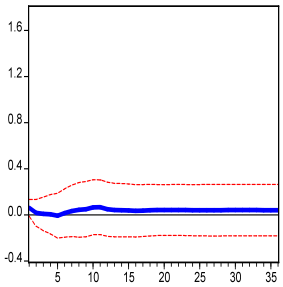
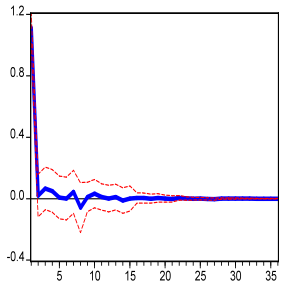


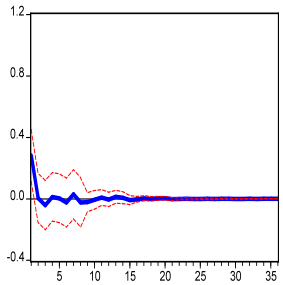
Figure 5: Impulse responses of lending rates (in Kip) to Kip discount rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

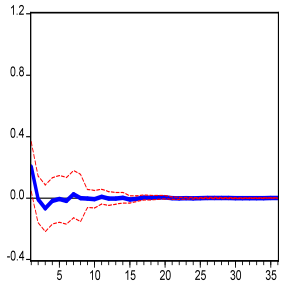
Response of Kip discount rate to Kip discount rate



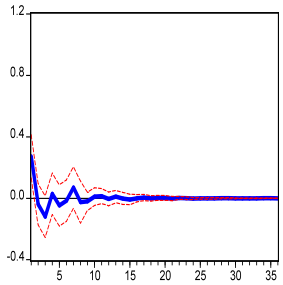
Response of Long-term 3-6yr lending rate to Kip discount rate



Response of Medium-term 1-3yr lending rate to Kip discount rate

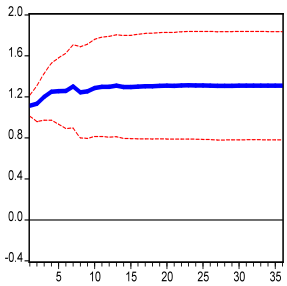


Response of Short-term 1yr lending rate to Kip discount rate

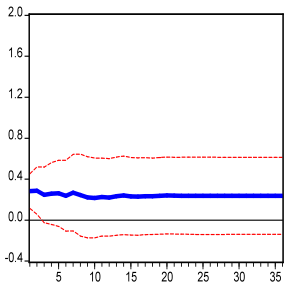


Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

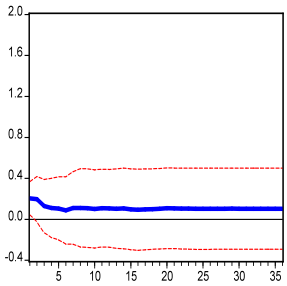
Accumulated Response of Kip discount rate to Kip discount rate



Accumulated Response of Long-term 3-6yr lending rate to Kip discount rate



Accumulated Response of Medium-term 1-3yr lending rate to Kip discount rate



Accumulated Response of Short-term 1yr lending rate to Kip discount rate

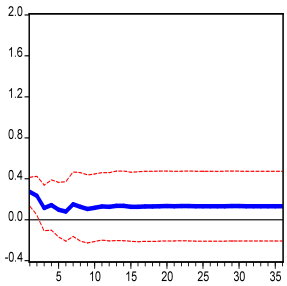
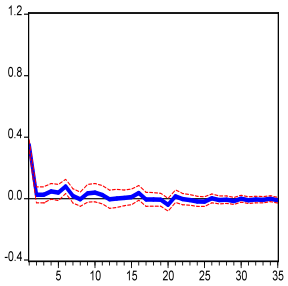


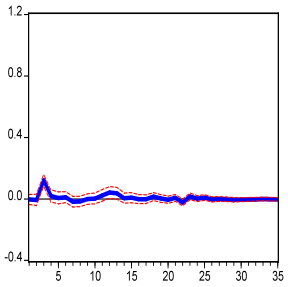
Figure 6: Impulse responses of deposit rates (in Baht) to Baht discount rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

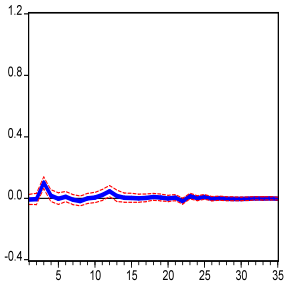
Response of Thai discount rate to Thai discount rate



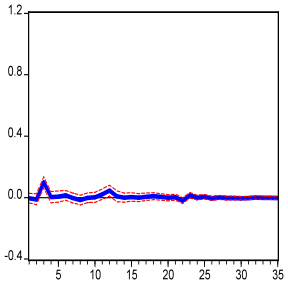
Response of Thai Deposit fixed 12 months rate to Thai discount rate



Response of Thai Deposit fixed 6 months rate to Thai discount rate

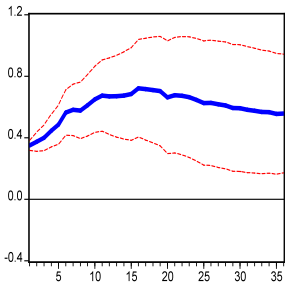


Response of Thai Deposit fixed 3 months rate to Thai discount rate

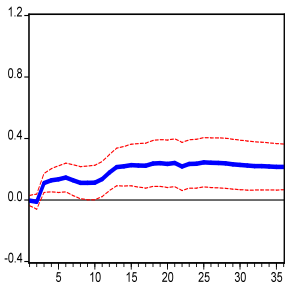


Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

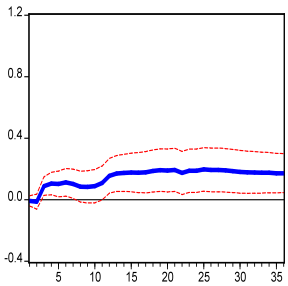
Accumulated Response of Thai discount rate to Thai discount rate



Accumulated Response of Deposit fixed 12 months rate to Thai discount rate



Accumulated Response of Deposit fixed 6 months rate to Thai discount rate



Accumulated Response of Deposit fixed 3 months rate to Thai discount rate

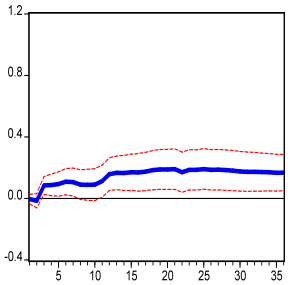
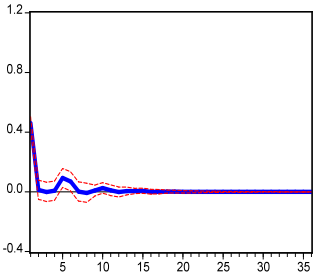


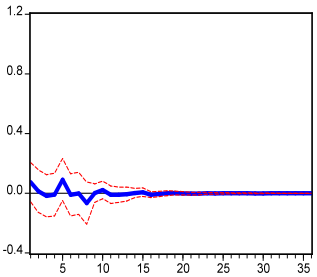
Figure 7: Impulse responses of lending rates (in Baht) to Baht discount rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

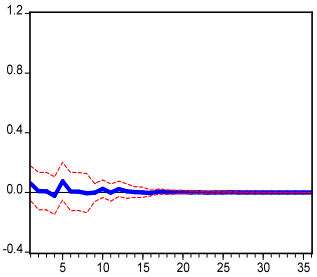
Response of Baht discount rate to Baht discount rate



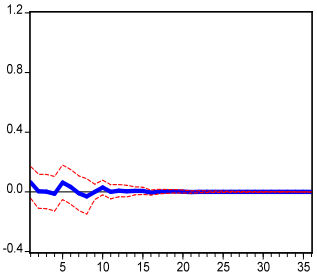
Response of Long-term 3-6yr lending rate to Baht discount rate



Response of Medium-term 1-3yr lending rate to Baht discount rate

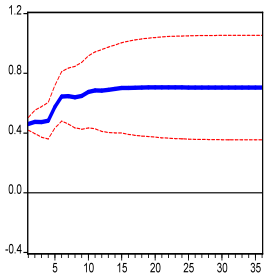


Response of Short-term 1yr lending rate to Baht discount rate



Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

Accumulated Response of Baht discount rate to Baht discount rate



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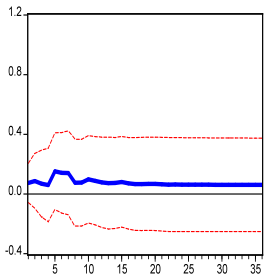
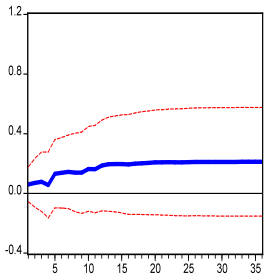


Accumulated Response of Medium-term 1-3yr lending rate to Baht discount rate



Accumulated Response of Short-term 1yr lending rate to Baht discount rate

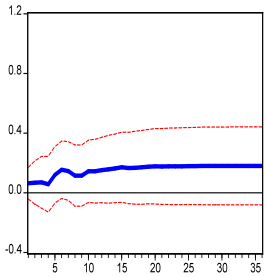
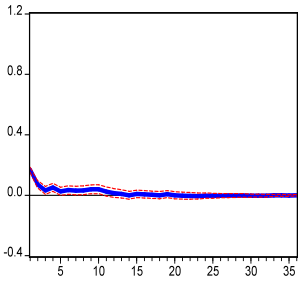


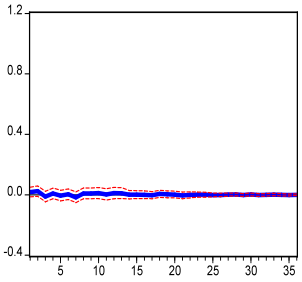
Figure 8: Impulse responses of deposit rates (in US dollar) to US dollar discount rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

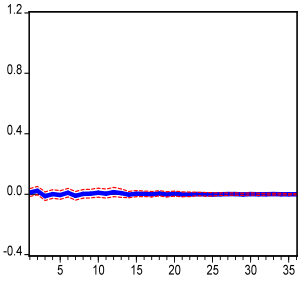
Response of USD discount rate to USD discount rate



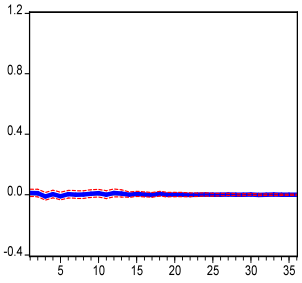
Response of Deposit fixed 12 months rate to USD discount rate



Response of Deposit fixed 6 months rate to USD discount rate

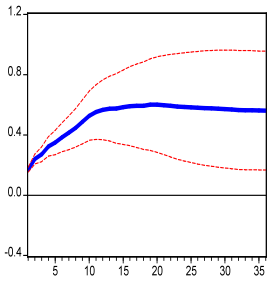


Response of Deposit fixed 3 months rate to USD discount rate

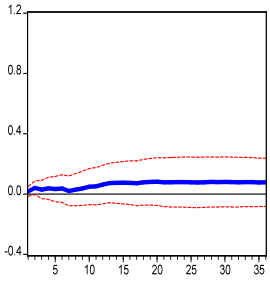


Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

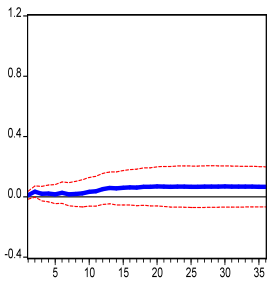
Accumulated Response of USD discount rate to USD discount rate



Accumulated Response of Deposit fixed 12 months rate to USD discount rate



Accumulated Response of Deposit fixed 6 months rate to USD discount rate



Accumulated Response of Deposit fixed 3 months rate to USD discount rate

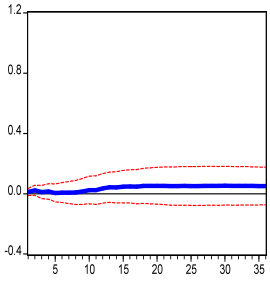
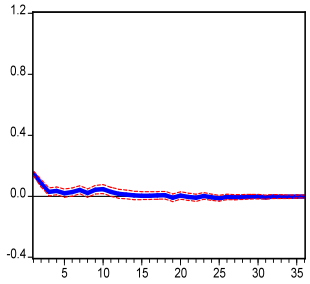


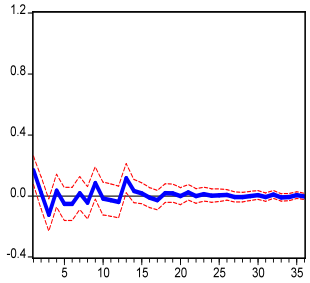
Figure 9: Impulse responses of lending rates (in US dollar) to US dollar discount rate

Response to Cholesky One S.D. Innovations ± 2 S.E.

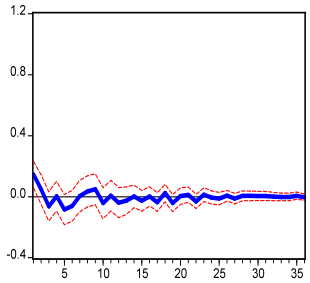
Response of USD discount rate to USD discount rate



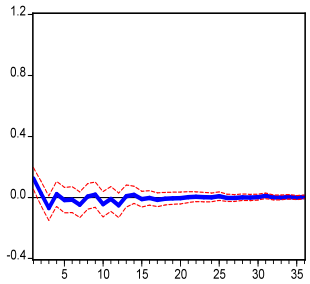
Response of Long-term 3-6yr lending rate to USD discount rate



Response of Medium-term 1-3yr lending rate to USD discount rate

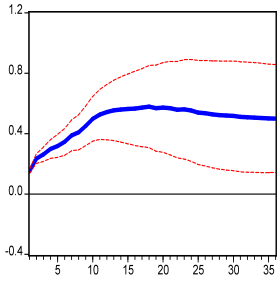


Response of Short-term 1yr lending rate to USD discount rate



Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.

Accumulated Response of USD discount rate to USD discount rate



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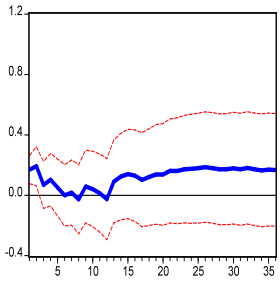
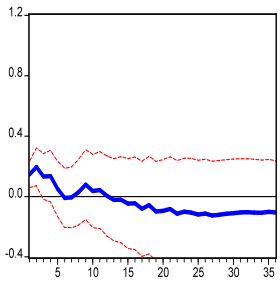
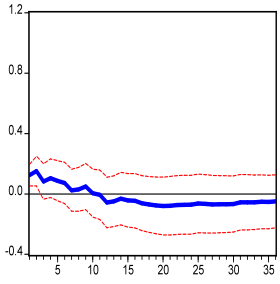


Accumulated Response of Medium-term 1-3yr lending rate to USD discount rate



Accumulated Response of Short-term 1yr lending rate to USD discount rate



6. Conclusion

In this study, we have empirically analyzed how retail interest rates respond to changes in Laos' policy rate. The results suggest that there exists no long-run equilibrium between the Kip discount rate and the retail interest rates. Results from the Cholesky-impulse response functions suggest that following one standard deviation shock in the change of Kip policy rate, both deposit and lending rates in Kip increase immediately by 0.1 and 0.2 percentage points respectively. After the first month, the responses drop back to zero and disappear in about two years. This indicates that retail interest rates in Kip do respond to the change in the policy rate but the responses are very small. Our results appear to agree with the result in Rocha (2012) for Portugal where monetary policy had a stronger effect on the cost of financing than the return on savings. These marginal responses also suggest that the use of the interest rate channel to achieve a desired real output and inflation target may not be the optimum channel in the case of Laos.

There are many explanations in the literature as to why interest rate pass-through is slow and/or small. For example, the lack of a sizable market for short-term monetary instruments (such as certificates of deposits or treasury bills) in Cottarelli & Kourelis (1994), barriers to entry in Moazzami (1999); bank consolidation in Olivero, Li, & Jeon (2011); exchange rate flexibility, banking sector concentration, liquidity ratio, non-performing loans ratios (NPLs), financial dollarization in Saborowski & Weber (2013); government bond yields in De Bondt, Mojon, & Valla (2005) are some of the determinants among many others. Two possible determinants that appear to be most likely to exhibit the characteristics of the financial market in Laos are the uncertainty of future economic policies and environment and the lack of competition in the market itself as argued by Kovanen (2011). Other determinants that are country specific may include: the in-active money market environment which could be due to an inadequate market size and that banks do not need liquidity smoothing (they have significant excess Kip liquidity), and thus, do not make demands on the BoL's lending facility. In this setting, banks would respond very little to policy rate changes especially in the short-run.

Furthermore, the results for foreign currencies suggest that while US dollar deposit rates do not significantly respond to the shock in US dollar policy rate, deposit rates in Baht respond to the change in the change of Baht policy rate with an increase of about 0.1 percentage point in the 2nd month but this decreases to zero by the end of the 4th month. Vice versa, lending rates in US dollar respond significantly with an increase of about 0.15 percentage points immediately following the shock and then fall to zero, while no significant response in Baht lending rates is found. Even though these responses for US dollar lending rates and Baht deposit rates are significant, they are small and suggesting minimal impact of interest rate pass-through from foreign monetary policy to foreign domestic interest rates.

There are a number of opportunities for further research. Firstly, these results suggest that an investigation into what factors determine Laos' banks' interest rates pricing is needed. Secondly, Kovanen (2011) suggests that one could also study market development factors that would contribute to a faster and more complete pass-through.

Acknowledgements

Special thanks to Bernd Hayo, Matthias Uhl, Ian Nield, Clive Johnson, Rishi Naikoo and Marina Merkl for helpful comments. All remaining shortcomings are mine.

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Appendix

Figure 1A: Deposit rates in USD

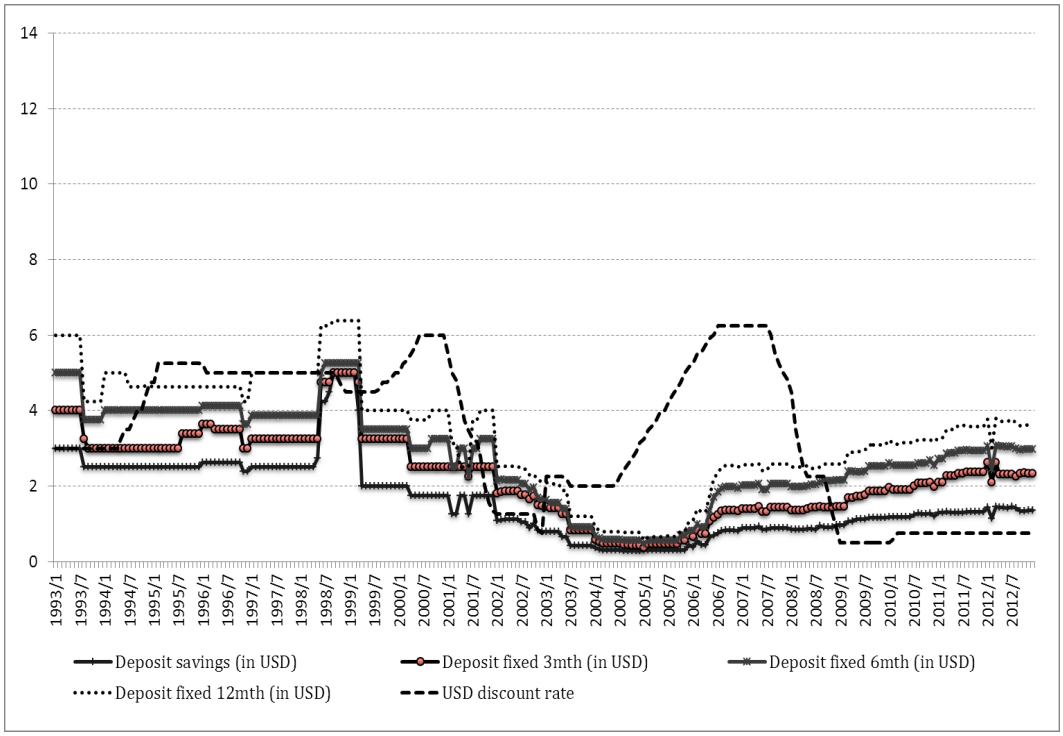


Figure 2A: Deposit rates in Baht

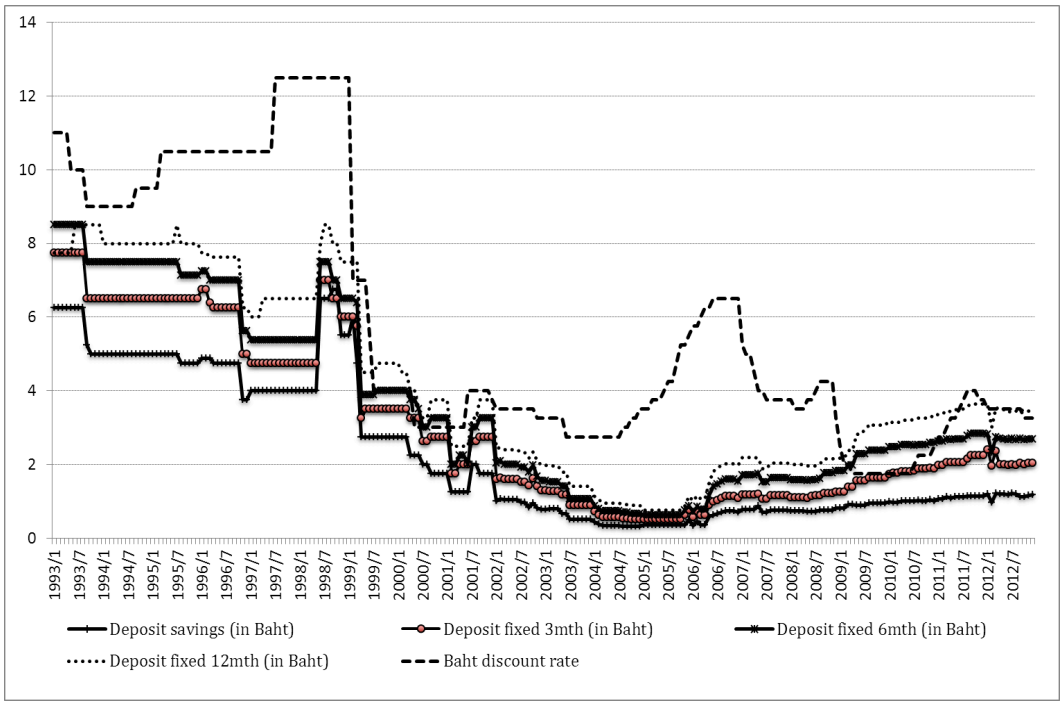


Figure 3A: Lending rates in US dollar

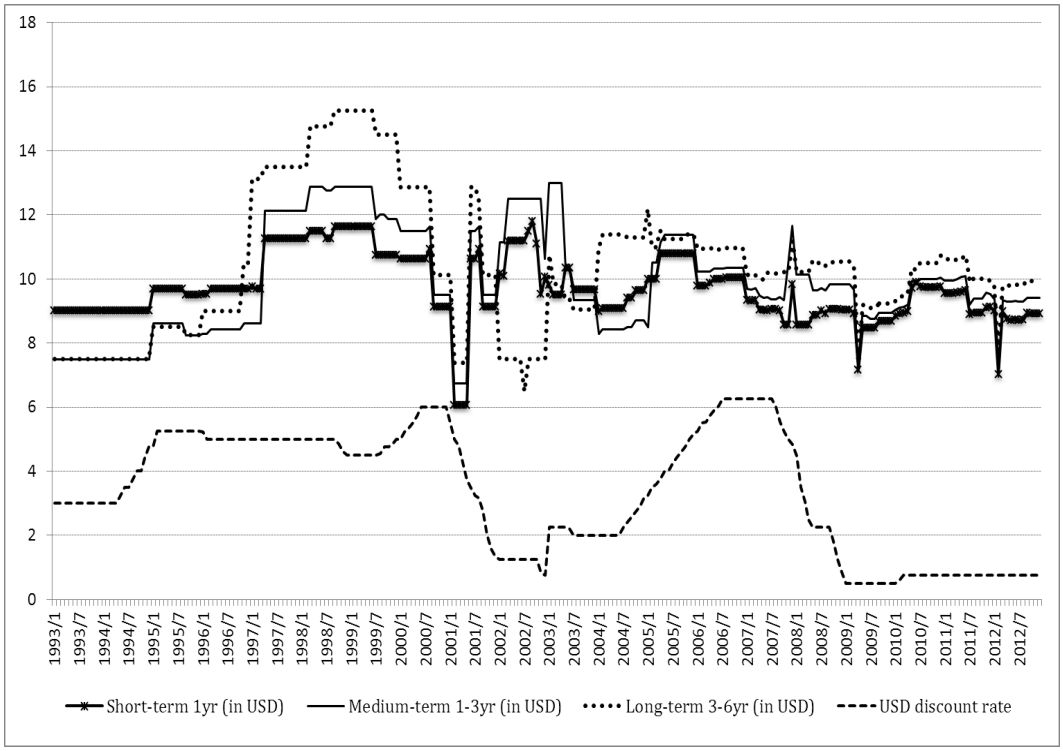
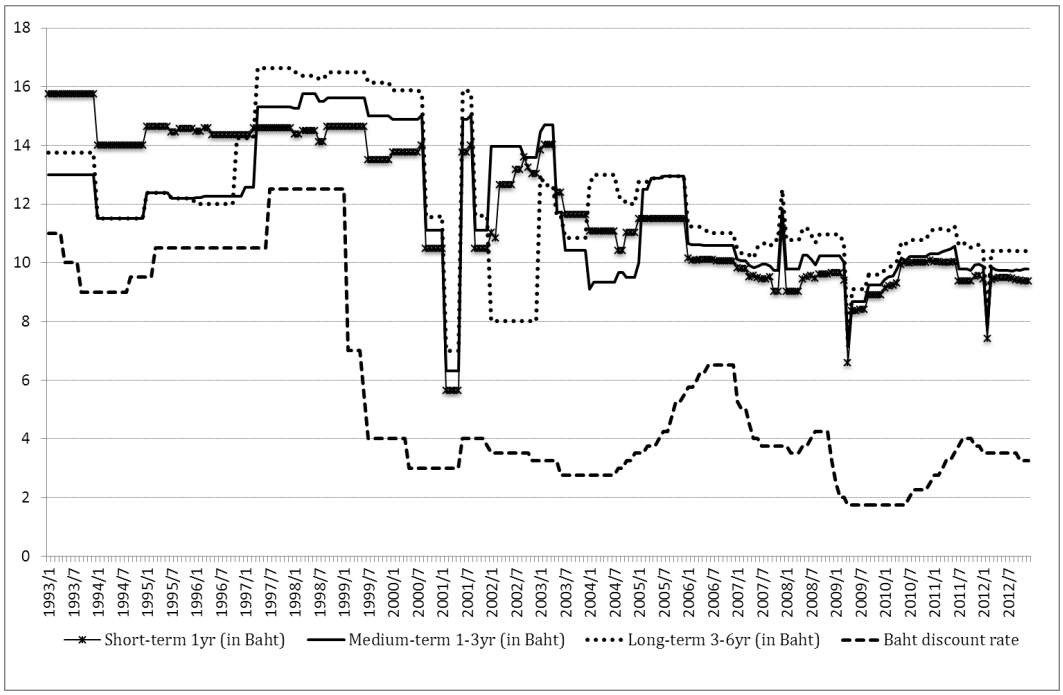


Figure 4A: Lending rates in Baht



Section 5

Inflation dynamics in the Lao People's Democratic Republic

Inflation dynamics in the Lao People's Democratic Republic

Vimaly Savannarideth

Philipps University Marburg, Department of Business and Economics, Universitaetsstraße 25, D-35037 Marburg. Email: Savannar@students.uni-marburg.de

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Abstract. This paper is an empirical investigation of monthly inflation dynamics in the Lao People's Democratic Republic (Laos) from 1993 to 2012. In a small vector autoregression framework, the Johansen cointegration test is used to investigate the presence of a long-run relationship between price level, real GDP, money supply and exchange rate. The test finds one long-run equilibrium among the included variables. The empirical results from the vector error correction model suggest that the long-run cointegration vector is significant in the short-run dynamics, with a coefficient of -0.12 implying that the tendency to return to the equilibrium after a shock is moderate as it takes approximately one year to return to the equilibrium. In addition, both real GDP and exchange rate growth strongly and positively influence inflation while money supply growth has a small effect. Lastly, an out-of-sample stability test, based on one-step ahead forecasts, shows that the model forecasts are stable.

JEL Classification: E52; E31

Keywords: Inflation, cointegration, short-run dynamics.

1. Introduction

The purpose of this paper is to empirically investigate the determinants of inflation in Laos. By understanding better what drives inflation in a country, the government authorities and the central bank (Bank of Lao PDR – BoL) can make informed decisions and use appropriate policy instruments to withstand negative impact from shocks. Studying inflation dynamics in Laos is important for two reasons. First, the study of inflation dynamics is itself an interesting topic, which should be kept up to date with the changing economic environment. As we move from one period to another, changes may take place, especially in the underlining economic structure, which could lead to a different inflation process. At this time, only one concrete study on inflation dynamics in Laos has been conducted. That is the study by Sengsourivong (2005) , who used data from 1994 to 2004. In this study, we contribute to the literature of inflation analysis in Laos by adopting a different econometric methodology and a more recent data set. Secondly, from a monetary operations perspective it is important to know whether monetary policy conducted through the management of money supply is likely to be successful in controlling inflation as targeted.

The causes of inflation vary depending on a country's economic fundamentals, and as a result, different models and factors of inflation determinants are considered for inclusion in the econometric models used in the various studies of inflation dynamics. This paper adopts a simple model, which is based on the framework of the quantity theory of money. The framework allows us to directly test the proportional relationship between money supply and the price level. This will indicate whether or not the BoL is likely to succeed in fighting inflation through the conduct of monetary policy using monetary control methods. One additional important factor that should be considered in the analysis is the exchange rate. The exchange rate is a crucial factor for Laos because there is a degree of dollarization and Laos' trade deficit. As Sengsourivong (2005) has pointed out, external monetary shocks work their way through the opportunity costs of holding domestic currency versus foreign currency. When many investors find that it is more attractive to hold foreign currency, a depreciation of the local currency will usually follow. In which case, there is a rise in import prices and hence, the overall prices. The situation is worsened if the country is experiencing a trade deficit. There is a broad body of empirical and theoretical literature support regarding the effect of exchange rate depreciation on inflation. It is therefore relevant to consider the exchange rate in this analysis. The study of Himarios (1987) for example, finds evidence that: "*the effects of devaluation on the price level lasted for at least three years*" and importantly, "*the anticipation of the devaluation can have severe inflationary consequences and can lead to price-level overshooting*". Goldfajn and Werlang's (2000) findings show that the longer the time horizon studied, the higher the pass-through coefficient of exchange rate depreciation is on inflation. In addition, the pass-through is lower in developed countries than that of emerging market economies. Thus, given that Laos is a dollarized economy with a persistent trade deficit, it is easier for the currency to experience periods of depreciation. Such

depreciations may affect the price level. As such, it is important to include the exchange rate in the analysis.

The remainder of the paper is organized as follows. Section 2 explains the econometric specification; section 3 details the data sources used and the results of the analysis. Section 4 presents detail of the short-run dynamic estimation and a conclusion is provided in section 5.

2. Econometric specification and data

There are many theoretical frameworks that could be used to study inflation dynamics. As the sources of inflation and the economic institutional frameworks vary from country to country, the appropriate frameworks that explain inflation differ as well. This paper adopts a simple model. As argued by Hayo (2000) the advantages of having a simple model are: i) having a large number of degrees of freedom, ii) having enough observations for out-of-sample analysis, and iii) avoiding the danger of over-fitting the equations to a specific sample. The theoretical framework of the quantity theory of money as used in Emerson (2006) is adopted in this analysis and can be specified as:

$$p_t + y_t = m_t + v_t, \quad (1)$$

where p is the log of price level, y is the log of real output, m is the log of money stock and lastly, v is the log of the velocity of money. Emerson (2006) assumes that the log velocity of money is a function of the nominal interest rate (INT), which can be written as:

$$v_t = ß_0 + ß_1 INT + \mu_t \quad (2)$$

Where $ß_0$ and $ß_1$ are coefficients and μ_t is a random error. When combining (1) and (2) we get

$$p_t = m_t + ß_0 + ß_1 INT + \mu_t - y_t \quad (3)$$

As mentioned in Duck (1993), many studies treat output and the quantity of money (and their growth rates) as exogenous variables and in such a case, equation (3) can be used for estimation. The exogeneity of the output variable can be reasoned from the perspective that output and its growth rate is exogenously determined by factors such as the change in technology and the characteristic of the work force among others (see Duck (1993)). In this analysis, we follow Emerson (2006) in making no assumptions about the exogeneity of the output and the quantity of money. Therefore, equation (4) as shown below is the base model adopted for our analysis.

$$p_t = ß_0 + ß_2 m_t + ß_3 y_t + ß_1 INT + \mu_t \quad (4)$$

The estimation model used in the analysis includes an exchange rate term as the log of the exchange rate (E) following Emerson (2006) and as shown in equation (5).

$$p_t = ß_0 + ß_2 m_t + ß_3 y_t + ß_1 INT + ß_4 E\ \mu_t \quad (5)$$

The data used in this study comes from two sources, the Bank of the Lao PDR (BoL) and Allthatstat.com. The data obtained from Allthatstat.com was originally sourced from the International Monetary Fund.

The following variables are considered in the study:

(1) LCPI = log of consumer price index (proxy for price level)
(2) LRGDP = log of real gross domestic product (proxy for output)
(3) LM = log of narrow money
(4) LMQ = log of broad money
(5) LER = log of the exchange rate being the number of Laos Kip per one US dollar
(6) Interest rate

The data set covers the period from May 1993 to December 2012 on a monthly basis and is in log-levels except for the interest rate. GDP data is not available on a monthly basis. Monthly GDP data employed in this study is estimated based on the application of the theory of best linear unbiased estimation in Chow & Lin (1971). Several steps are involved in the estimation beginning with the estimation model used to obtain the estimated coefficients which is represented as: $GDP = \alpha + ß_1 Export_t + ß_2 Export_{t-1} + ß_3 Import_t + ß_4 Import_{t-1} + ß_5 Import_{t-2} + \varepsilon$. Further details of the procedures of the estimation can be found in Savannarideth (2015). The one-year commercial deposit interest rate is used as the proxy for interest rate.

3. Econometric approach and results

Seasonality, unit root and cointegration test

Using X12-ARIMA, we ran a seasonality test on each of the variables. Seasonality was detected only in narrow money, which was adjusted accordingly. Details of the tests results can be provided upon request. Following the seasonality tests, unit root tests were performed using both the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) methods. The results of these tests are provided in tables 1 and 2. The unit root tests suggested that all the variables are integrated of order one (I(1)).

Table 1. Augmented Dickey-Fuller test

ADF test	with constant	with constant and linear trend	without constant or linear trend
Test at log-level	ADF statistic	ADF statistic	ADF statistic
Log of narrow money	-0.36	-2.42	5.64
Log of broad money	-1.45	-1.08	7.66

Log real GDP	-2.88*	-9.61*	2.18
Log of consumer price index	-1.80	-0.73	1.88
Log of the exchange rate	-2.12	-0.74	1.58
Interest rate	-0.41	-1.90	-1.12
Test at first difference			
△Log of narrow money	-17.18*	-17.15*	-4.55*
△Log of broad money	-14.42*	-14.49*	-5.40*
△Log real GDP	-7.96*	-7.95*	-9.31*
△Log of consumer price index	-5.4*	-5.66*	-4.73*
△Log of the exchange rate	-7.78*	-8.13*	-7.53*
△Interest rate	-9.85*	-9.87*	-9.79*

Automatic lag selection base on Schwarz information criterion with maximum lag=14. Null hypothesis: Variable has a unit root. One asterisk indicates a rejection of the Null at 5 percent significance level.

Table 2. Kwiatkowski-Phillips-Schmidt-Shin test

KPSS test	with constant	with constant and linear trend
Test at log-level	KPSS statistic	KPSS statistic
Log of narrow money	2.07*	0.18*
Log of broad money	1.99*	0.39*
Log real GDP	1.96*	0.10
Log of consumer price index	1.70*	0.45*
Log of the exchange rate	1.40*	0.47*
Interest rate	1.60*	0.30*
Test at first difference		
△Log of narrow money	0.10	0.10
△Log of broad money	0.28	0.11
△Log real GDP	0.03	0.02
△Log of consumer price index	0.54*	0.12
△Log of the exchange rate	0.61*	0.11
△Interest rate	0.05	0.04

Spectral estimation method: Bartlett Kernel, Bandwidth: (Newey-west using Bartlett Kernel). Null hypothesis: Variable is stationary. One asterisk indicates a rejection of the Null at 5 percent significance level.

The Johansen cointegration test was adopted to identify the long-run equilibrium of the included I(1) variables. The test allowed us to identify the number of cointegrating vector that the variables would permit in a system. The test was conducted using a VAR framework, which also identified the appropriate number of lags to be included in the system based on the various information criteria.

With the appropriate number of lags selected, a Johansen cointegration test was performed and provided two test statistics: the maximum eigenvalue and the trace test, which is based on the sum of

the eigenvalues. Many combinations of specifications were estimated by alternating broad money and narrow money and also when the interest rate and/or the exchange rate are added into the system. Lastly, dummy variables were considered for the financial crisis in 1997. From these cointegration analyses, we drew three conclusions:

(1) The inclusion of interest rate in the system leads to the reduction of significance level and a mix of "wrong sign effects" for the variables in the system. The t-statistic of the interest rate variable is insignificant and takes on the wrong sign, which suggests that an increase in interest rate leads to an increase in inflation. This finding of the insignificance of the interest rate variable was expected because the link between interest rate and other macroeconomic variables in the case of Laos appears to be weak. By excluding the interest rate, the cointegrating vector becomes meaningful and significant.

(2) Broad money has a greater significance level than narrow money.

(3) We identify dummy variables (dummies) for years 1997, 1998, and 1999 to take into account the effect of the Asian financial crisis. Combinations of different sets of dummies are considered as well as each individual dummy alone in different sets of variables. Of the various dummies, only the inclusion of dummy 1997 provides a meaningful and significant cointegration vector.

From the results of the cointegration analysis, we have identified a potential model for the final VAR system of the endogenous variables namely, LCPI, LRGDP, LMQ, LER. The result of the cointegration test is presented in table (3). Both the maximum eigenvalue test and the trace test suggest that at a 5 percent significance level, there exists one cointegating vector for the included variables. The adjustment parameter for the error correction term of the inflation equation is -0.13, which implies that a deviation from the long-run equilibrium does exert a reasonable pressure on inflation growth. The unrestricted long-run cointegrating equation lagged by one period is represented by $LCPI_{t-1}$ - $0.67LRGDP_{t-1}$ - $0.15LMQ_{t-1}$ - $0.65LER_{t-1}$ + 8.05. Both GDP and exchange rate exert a considerable positive effect on CPI, while broad money does so to a lesser extent. In another words, LCPI is positively correlated with LRGDP and LMQ and LER. It can be interpreted that, if LRGDP increases by 1 percent, it is expected that LCPI will increase by 0.67 percent. Similarly, LCPI is expected to increase by 0.65 percent if there is a 1 percent increase in LER. In this long-run equilibrium, LMQ takes the smallest coefficient of 0.15, this suggest that when LMQ is expected to increase by 1 percent, then LCPI would increase by 0.15 percent.

Table 3. Estimating and testing unrestricted cointegrating vector

Lag length: 12

H_0	Eigenvalue	LR(r, r+1)	LR(r, N)
r = 0	0.31	75.18*	104.86*
r ≥ 1	0.08	17.32	29.68
r ≥ 2	0.05	11.39	12.35

Notes: LR(r, r+1) is the test statistics for the maximum eigenvalue test, and the LR(r,N) for the trace test. One asterisk indicates a rejection of the Null at the 5% significance level. The critical values are based on MacKinnon-Haug-Michelis (1999). Period examined 1994M06 to 2010M12.

Restricted cointegration analysis

A restricted cointegration test was applied to both the cointegrating and adjustment vectors. The results are detailed in table (4). The test was conducted on the cointegrating vector and three adjustment vectors corresponding to real GDP, broad money and exchange rate. The restriction test for the cointegrating vector was applied to verify whether the quantity theory of money holds, assuming that the elasticity of LRGDP is equal to -1 and the elasticity of LMQ is equal to 1. The result of the joint hypothesis test suggests that the restriction is rejected at 5 percent significance level. As shown by Johansen (1992), by applying a restriction test on the adjustment vectors, it will help us find out whether it is possible to model our equation of interest, being the inflation equation in this study, in a specific modeling form a general one or not. The results suggest that the exchange rate and the money supply variables are weakly exogenous with respect to the inflation equation. Therefore, the dynamic modeling can proceed within a two-equation system comprising the inflation and the output equations, with corresponding error correction term of $LCPI_{t-1} - 0.67LRDGP_{t-1} - 0.15LMQ_{t-1} - 0.65LER_{t-1} - 8.09$, that has a significant loading parameter of -0.13.

Table 4: Testing restriction on the cointegrating and adjustment vectors

Test restriction on the cointegrating vector, n. of lag: 12

LR test for binding restrictions (rank =1) LR test of restrictions:

LCPI	LRGDP	LMQ	LER	Chi-square	Prob.	Result
1	1	-1	U	Chi-square(2)= 58.22	0.00	Reject restriction.

Test restriction on the adjustment vectors

LR test for binding restriction (rank=1) LR test of restrictions:

LCPI	LRGDP	LMQ	LER	△LCPI	△LRGDP	△LMQ	△LER	Chi-square	Prob.	Result
1	U	U	U	U	U	U	**0**	Chi-square(1)= 0.21	0.64	Accept restriction.
1	U	U	U	U	U	**0**	U	Chi-square(1)= 0.50	0.48	Accept restriction.
1	U	U	U	U	**0**	U	U	Chi-square(1)= 46.99	0.00	Reject restriction.

1	U	U	U	U	U	**0**	**0**	Chi-square(2)= 0.53	0.77	Accept restriction.

Cointegration test (rank:1) with specification: No intercept or trend in CE and VAR. "U" signifies unrestricted.

Estimating short-run inflation dynamics

The estimation starts with estimating an unrestricted two-equation VAR in first differences of LCPI, LRGDP on the lagged values of LCPI, LRGDP, LMQ, LER in differences, the restricted cointegrating vector as a lagged error correction term, and a dummy variable. Next, an F-test at the 5 percent significance level is applied to the general model in order to eliminate as many insignificant variables as possible while maintaining satisfactory statistical properties of the system. For example, the first group of insignificant variables is identified and the F-test is applied. If the restriction is accepted, we proceed to estimate the reduced model. Based on results from the reduced model, a new group of variables is identified for exclusion, then the F-test is applied to the new group of variables together with the old group of variables and, when the restriction is accepted, it is possible to proceed to estimating the reduced model. The procedure is repeated until as many variables as possible have been eliminated and only variables with a significance level of 10 percent or lower are left, while maintaining the statistical property of the system. As an estimator, the full information maximum likelihood (FIML) method has been utilized. The technique was chosen because FIML is a consistent and asymptotically efficient estimation method due to the fact that it accounts for the information that contemporaneous correlation exists between the disturbance terms of the complete model (Vogelvang (2005) p455, Studenmund & Cassidy (2001) p226).

4. Estimating short-run inflation function

The estimated dynamic error correction model is shown in table (5). On inspection of the VAR, we determined that the system is free from autocorrelation but not from the presence of heteroskedasticity; therefore, a heteroskedasticity consistent standard error was applied. Equation △LCPI represents the dynamic inflation function, which is the equation of interest. The results suggest that:

(1) The error correction term has a coefficient of -0.12 with the correct sign and it is significant. This implies that when there is a shock affecting the system, there will not be a strong force that will drive the deviation back to the long-run equilibrium.

(2) Lagged △LCPI namely, $\triangle LCPI_{t-2}$, $\triangle LCPI_{t-4}$, $\triangle LCPI_{t-11,}$ and $\triangle LCPI_{t-12}$ are found to have a significant impact on current inflation with the correct sign and respectively taking coefficients of 0.28, 0.19, 0.27 and 0.27. Their net total effect sum to 1.01, which implies that inflation during previous periods is very important in explaining current inflation and the impact appears to be persistent over a very long lag length. In another words, the net sum

effect of inflation from two, four, eleven and twelve periods ago has a proportional effect on inflation today.

(3) Lagged △LRGDP appears to be very important for explaining inflation as well and it is found to have a lag length of up to 12 months. The total net effect of lagged △LRGDP sums to -0.66, which is quite large. The negative association between inflation and real GDP growth appears to support the claim made by Durevall and Sjö (2012) and Kabundi (2012) that developing countries are more likely to exhibit a strong negative relationship between business cycle and inflation.

(4) Turning to the money supply variables, $\triangle LMQ_{t-2}$, $\triangle LMQ_{t-4,}$, $\triangle LMQ_{t-7}$, and $\triangle LMQ_{t-9}$ are found to be significant in explaining inflation with the correct sign for economic interpretation. Their total net effect sum to 0.43, implying that the growth of past money supply does influence current inflation.

(5) The exchange rate lagged variables on the other hand have coefficients with mixed signs. Only $\triangle LER_{t-5}$ has the correct sign as expected by theory, with a coefficient of 0.05. However the total net effect of exchange rate growth sums to -0.46. At this stage there is no theoretical explanation as to why the sign is not in accordance with theory in the short-run even though exchange rate does have the correct sign in the long-run equilibrium.

The real output growth equation represented by equation △LRGDP is not the main equation of interest in the system of equations for this analysis so the results are only summarized. The dynamic estimation results suggest that i) lagged real GDP growth has a significant and strong positive influence on current real GDP growth, ii) past inflation negatively affects growth of real GDP with a net total effect of -5.18, iii) lagged growth of money supply contributes to real GDP growth with a net total effect of 0.28, iv) the net total effect of exchange rate growth positively influences the growth of real GDP with a value of 4.38, which appears to suggest that depreciation boosts real GDP growth, and lastly, v) the cointegrating equation is significant in explaining the growth of real GDP; it takes a very large value of 0.78 implying that there is a strong tendency that after a shock the deviation is going to return to the long-run equilibrium.

Out-of-sample analysis for the inflation equation is shown in figure (1). The one-step ahead forecast for inflation equation has an encouraging outcome, where all forecasts are within the confidence intervals (two standard errors) represented by the bars.

Figure 1: Short-run forecasts of inflation equation

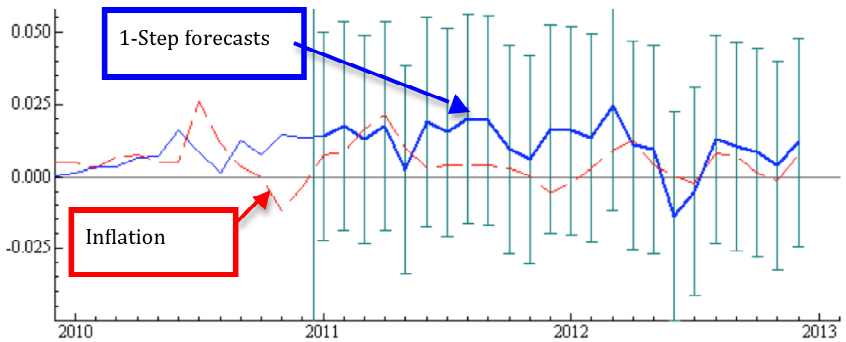

Table 5: Dynamic error correction model

	Equation for: △LCPI					Equation for: △LRGDP					
	Coeffi.	**SEs**	**HCSE**	**t-HCSE**	**t-prob**		**Coeffi.**	**SEs**	**HCSE**	**t-HCSE**	**t-prob**
$\triangle LCPI_{t-2}$	0.28	0.07	0.10	2.88	0.00	$\triangle LCPI_{t-2}$	-0.60	0.31	0.31	-1.88	0.06
$\triangle LCPI_{t-4}$	0.19	0.06	0.08	2.42	0.02	$\triangle LCPI_{t-4}$	-1.16	0.32	0.36	-3.17	0.00
$\triangle LCPI_{t-11}$	0.27	0.06	0.08	3.28	0.00	$\triangle LCPI_{t-6}$	-0.97	0.31	0.34	-2.86	0.00
$\triangle LCPI_{t-12}$	0.27	0.06	0.07	3.65	0.00	$\triangle LCPI_{t-8}$	-1.40	0.33	0.32	-4.45	0.00
$\triangle LRGDP_{t-1}$	-0.13	0.01	0.02	-7.75	0.00	$\triangle LCPI_{t-9}$	0.66	0.32	0.27	2.43	0.02
$\triangle LRGDP_{t-2}$	-0.09	0.01	0.01	-5.97	0.00	$\triangle LCPI_{t-11}$	-1.04	0.29	0.31	-3.40	0.00
$\triangle LRGDP_{t-3}$	-0.07	0.01	0.02	-4.14	0.00	$\triangle LCPI_{t-12}$	-0.68	0.31	0.36	-1.89	0.06
$\triangle LRGDP_{t-4}$	-0.04	0.01	0.01	-3.35	0.00	$\triangle LRGDP_{t-1}$	0.44	0.06	0.06	7.56	0.00
$\triangle LRGDP_{t-5}$	-0.10	0.01	0.02	-3.89	0.00	$\triangle LRGDP_{t-2}$	0.52	0.06	0.07	7.82	0.00
$\triangle LRGDP_{t-6}$	-0.05	0.01	0.01	-4.29	0.00	$\triangle LRGDP_{t-5}$	0.10	0.06	0.05	2.01	0.05
$\triangle LRGDP_{t-7}$	-0.04	0.01	0.02	-2.34	0.02	$\triangle LRGDP_{t-7}$	0.12	0.05	0.05	2.45	0.02
$\triangle LRGDP_{t-8}$	-0.06	0.01	0.01	-5.13	0.00	$\triangle LRGDP_{t-12}$	0.09	0.05	0.04	2.17	0.03
$\triangle LRGDP_{t-9}$	-0.02	0.01	0.01	-2.18	0.03	$\triangle LMQ_{t-1}$	0.64	0.16	0.17	3.80	0.00
$\triangle LRGDP_{t-11}$	-0.03	0.01	0.01	-3.61	0.00	$\triangle LMQ_{t-2}$	-0.39	0.17	0.20	-1.93	0.06
$\triangle LRGDP_{t-12}$	-0.03	0.01	0.01	-2.58	0.01	$\triangle LMQ_{t-6}$	0.48	0.17	0.16	3.01	0.00
$\triangle LMQ_{t-2}$	0.16	0.04	0.04	4.52	0.00	$\triangle LMQ_{t-9}$	-0.49	0.15	0.14	-3.48	0.00
$\triangle LMQ_{t-4}$	0.08	0.04	0.03	2.25	0.03	$\triangle LMQ_{t-10}$	-0.30	0.16	0.11	-2.58	0.01
$\triangle LMQ_{t-7}$	0.10	0.04	0.03	2.89	0.00	$\triangle LMQ_{t-12}$	0.34	0.16	0.17	2.03	0.04
$\triangle LMQ_{t-9}$	0.10	0.03	0.03	3.13	0.00	$\triangle LER_{t-1}$	-0.38	0.13	0.17	-2.19	0.03
$\triangle LER_{t-2}$	-0.10	0.03	0.04	-2.58	0.01	$\triangle LER_{t-2}$	1.49	0.15	0.19	7.73	0.00
$\triangle LER_{t-4}$	-0.06	0.03	0.03	-1.77	0.08	$\triangle LER_{t-3}$	0.38	0.13	0.14	2.67	0.01
$\triangle LER_{t-5}$	0.05	0.03	0.03	1.83	0.07	$\triangle LER_{t-4}$	0.27	0.14	0.13	2.13	0.03
$\triangle LER_{t-7}$	-0.08	0.04	0.04	-2.26	0.03	$\triangle LER_{t-5}$	0.33	0.13	0.11	3.01	0.00
$\triangle LER_{t-8}$	-0.05	0.03	0.03	-1.74	0.08	$\triangle LER_{t-6}$	0.94	0.15	0.13	7.13	0.00
$\triangle LER_{t-9}$	-0.08	0.03	0.03	-2.24	0.03	$\triangle LER_{t-8}$	0.64	0.15	0.16	3.93	0.00
$\triangle LER_{t-12}$	-0.15	0.03	0.03	-4.56	0.00	$\triangle LER_{t-9}$	0.67	0.15	0.16	4.16	0.00
COINTEQ	-0.12	0.01	0.02	-5.86	0.00	$\triangle LER_{t-10}$	0.34	0.14	0.13	2.65	0.01
						$\triangle LER_{t-12}$	-0.31	0.15	0.14	-2.18	0.03
						COINTEQ	0.78	0.06	0.08	9.49	0.00

AR 1-7 test : F(7, 165) = 1.18 [0.32]	AR 1-7 test : F(7, 163) = 0.33 [0.94]
Normality test : Chi^2 (2) = 12.99 [0.00]**	Normality test : Chi^2 (2) = 4.10 [0.13]
Hetero test : F(54, 144) = 1.90 [0.00]**	Hetero test : F(58, 140) = 0.92 [0.63]

Vector SEM-AR 1-7 test : F(28,312) = 1.22 [0.21]

Vector Normality test : Chi^2 (2) = 17.30 [0.00]**

Vector Hetero test : F(297, 140) = 1.94 [0.00]**

5. Conclusion

The cointegration test suggests that there exists a long-run equilibrium for the included variable LCPI, LRGDP, LMQ and LER. The cointegrating vector is represented by LCPI – 0.67LRGDP – 0.15LMQ – 0.65LER + 8.1. This suggests that in the long-run, LRGDP, LMQ and LER have positive influence on LCPI, taking coefficient of 0.67, 0.15, and 0.65 respectively. LRGDP and LMQ appear to have very large coefficients. It can be interpreted that if real GDP increases by 1 percent, CPI would increase by 0.67 percent. Similarly, an increase (or a depreciation) of 1 percent in the exchange rate would increase CPI by 0.65 percent. For the money variable, an increase of 1 percent will increase the consumer price index by 0.15 percent. This implies that LRGDP, LMQ and LER are important factors explaining the price level in the long-run. The restriction test on the cointegrating vector suggests that the quantity theory of money has to be rejected at 5 percent significance level when assuming negative unity for the elasticity of real GDP and unity for the elasticity of money variables. The results of the restriction test on the adjustment vectors suggest that money and exchange variables are weakly exogenous with respect to the inflation equation, and thus, the dynamic system is estimated within a system of two-equations.

Coming to the short-run dynamic equation for △LCPI (inflation), we find that the error correction term takes a coefficient of -0.12, which is moderate and implying that the tendency to return to the equilibrium after a shock would take one year. Lags of inflation are found significant in explaining current inflation with a net total effect of 1.01. Lags of △LRGDP (real GDP growth) also appear to have very strong influence with relatively long lag lengths on current inflation with a total net effect of -0.66. The negative association between inflation and real GDP growth supports the claim made by Durevall and Sjö (2012) and Kabundi (2012) that developing countries are more likely to have a strong negative relationship between business cycle and inflation. This appears to be so for Laos in the short-run but not so in the long-run. Lags of money growth have a net effect of 0.43 implying that the growth of past money supply will raise the inflation rate. Lags of the exchange rate growth variables have mixed signs with a net total effect of -0.46, which is not economically intuitive. As mentioned in the introduction, the inclusion of the exchange rate variable is important for the case of Laos given the presence of dollarization and a persistent trade deficit. It appears that exchange rate does explain the price level in the long-run with a considerably large coefficient and the correct sign as expected in the theory, but in the short-run the opposite sign effect is found. At this point, we do not have any concrete explanation to explain why in the short-run, the exchange rate growth has a net negative impact on inflation.

In terms of policy implications, the evidence of the long-run equilibrium suggests that the price level can be explained by real GDP, money supply and exchange rate. Real GDP and exchange rate do appear to have very strong influence on the price level while money supply to a lesser extent. The

long-run equilibrium supports the fact that the money variable is important in explaining the price level in the long-run and that the central bank could possibly use money supply to controlling inflation. This is further supported by the results from the short-run dynamic analyses, where the growth of lagged money supply has a considerably large positive impact on inflation in accordance with theory. Furthermore, attention should also be put on the lags of inflation, which appears to have the strongest effect on the current inflation.

There are several avenues for further research on the topic of inflation in the case of Laos. As mentioned earlier, many factors including: fiscal, monetary, real and balance of payment factors can affect inflation. However, in this study, we have not been able to incorporate the variables from the different sectors of the economy into the analysis especially from the fiscal and the balance of payments side due to model limitation as well as data availability. It would be of further interest to investigate the association between fiscal factors and inflation in more detail. As the study of Catão and Terrones (2005) has shown, deficits and inflation are strongly and positively correlated especially among high-inflation countries and developing country groups. For example, there could be a strong relationship between deficits and inflation if the government tries to finance the deficits by increasing administered prices and/or taxes.

Regarding the topic of dollarization, there are several issues that warrant further investigation. The study by Sengsourivong (2005) has provided evidence that the dollarization index explains variation of inflation in Laos. It would be of interest to further investigate and/or conduct surveys to identify factors that affect the decisions of households in holding foreign currency versus local currency. This topic is of importance because as long as foreign currency holding is still a large part of the money supply, the central bank will have limited ability to control the money supply and hence, inflation effectively. The exchange rate itself is another topic that is clearly related to dollarization. In the case where it is more attractive to hold foreign currency, this will put pressure on the local currency to depreciate and hence, inflation may follow. Himarios (1987) provides evidence that devaluation and the anticipation of devaluation both have severe inflationary consequences. Siliverstovs and Bilan (2005), by using a proxy for devaluation expectations, found that the devaluation of expectation had the most influence on price development in the Ukraine. Given that the exchange rate variable does have a strong association with price in this analysis, it would be important in Laos' case, to identify factors contributing to exchange rate volatility, exchange rate devaluation, and the expectation of exchange rate devaluation. This would assist policy makers in considering how to stabilize those factors and so more effectively stabilize inflation.

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Section 6

Does the monetary model of exchange rate explain the exchange rate between Lao Kip and U.S. dollar?

Does the monetary model of exchange rate explain the exchange rate between Lao Kip and U.S. dollar?

Vimaly Savannarideth

Philipps University Marburg, Department of Business and Economics, Universitaetsstraße 25, D-35037 Marburg. Email: Savannar@students.uni-marburg.de.

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Abstract. This paper studies the Lao Kip/U.S. dollar exchange rate using the monetary model. The cointegration test is adopted to find the long-run equilibrium between exchange rate, money supply differential, real output differential and interest rate differential. According to the trace test, three cointegrating vectors are found but appear to be unstable. The maximum eigenvalue test suggests that there is one cointegrating vector. Although this cointegrating vector is stable, the estimated parameters are not consistent with the monetary model. In particular, we find that the money variable is insignificant. As a result, we find no strong evidence that the monetary model can be used to explain the exchange rate between Lao Kip and U.S. dollar.

JEL Classification: E52;

Keywords: Nominal exchange rate, monetary exchange rate model, cointegration.

1. Introduction

One consequence of the Asian financial crisis in 1997 was that several ASEAN countries, including Laos, abandoned their fixed exchange rate regimes. As a result, various forms of a flexible exchange rate regime were adopted. Given that the Laos Kip is not fixed anymore, it is important to ask what drives the behavior of the exchange rate and are there certain systemic forces that can explain the path of the exchange rate in Laos. Popular economic models that try to explain these systemic forces include: purchasing power parity, uncovered interest rate parity, the monetary model, the Mundell-Fleming model and variants of these models. Ideally, all these models would be tested in an empirical framework and compared.

In this study, the monetary approach to exchange rate is chosen as the focus for the analysis of the exchange rate in Laos. Literature on the model by Frenkel (1976), Dornbusch (1976), and Frankel (1979) for example, have received much attention. Early empirical results have found unsatisfactory support for the monetary model, especially the study by Meese & Rogoff (1983). Later, improvements in the econometric models and the convincing idea that the purchasing power parity would only exist in the long-run brought about more evidence of this long-run relationship. Woo (1985), Somanath (1986), Finn (1986) have found evidence supporting the monetary approach despite contrasting results from Meese & Rogoff (1983). MacDonald & Taylor (1991, 1993, 1994a, 1994b), Reinton & Ongena (1999), and Tawadros (2001) have found evidence for long-run equilibrium of the monetary model, and this equilibrium is also found in high inflation countries in the study by McNown & Wallace (1994). Evidence from specific countries includes those by Reinton & Ongena (1999) for Norway, Chin, Azali, Yusop, & Yusoff (2007) for the Philippines, Baharumshah, Mohd, & Ahn (2009) for Malaysia, Uz & Ketenci (2010) for new EU members and Turkey, and Adawo & Effiong (2013) for Nigeria.

Despite numerous studies on the long-run relationship of the monetary approach in the extant literature, there is agreement among researchers that the monetary model should be further investigated and more empirical analysis should be conducted for a wider range of countries. The reason for this is that different countries exhibit different characteristics and the relationship between their macroeconomics variables and the exchange rate varies depending on a variety of fundamentals. Therefore, the monetary model may or may not be compelling for a particular country. Given some positive evidence in the literature of the model as a long-run equilibrium as mentioned earlier, it is helpful to find out if the model can explain any systematic forces for the case of Laos. The remainder of the paper is organized as follows. A review of relevant literature is presented in section 2. Section 3 covers the theoretical model, followed by an explanation of the econometric procedures and results in section 4. Section 5 provides conclusions.

2. Literature review

The monetary model of exchange rate is a framework that views the exchange rate as the relative price of two monies with the demand for money playing an important role in determining the exchange rate levels. Empirical studies in the early 1980s that tried to verify the usefulness of the framework include Meese & Rogoff (1983), Woo (1985), Somanath (1986), Finn (1986). During this period, the work of Meese & Rogoff (1983) casts doubt on the ability of the monetary approach to predict the future exchange rate. This is because they found that the monetary model performs poorly in out-of-sample forecasts when compared with a random walk for the currencies: pound, mark, yen and the trade-weighted dollar. Later, Woo (1985) and Somanath (1986) by including a lagged term for the exchange rate showed that the monetary approach performs better than that of the random walk. This was followed by Finn (1986) who showed that by accounting for the infinite expected future values of money supplies, real income and foreign interest rates, the rational expectations monetary model performs as well as the random walk. The results from these different specifications lend some support to the monetary approach for explaining the exchange rate.

Later, the work of MacDonald & Taylor (1991), who examined the monetary policy approach to exchange rate determination for three key currencies, showed that by adopting the multivariate cointegration technique as proposed by Johansen (1988, 1991), that they could find evidence of a long-run equilibrium between the exchange rate and monetary variables. Based upon this finding, they proposed that the monetary model approach should also emphasize this long-run equilibrium of the exchange rate. Similar work carried out by MacDonald & Taylor (1993, 1994b), Reinton & Ongena (1999) and Tawadros (2001) also found a long-run equilibrium using the monetary model. Furthermore, they also found that by including an error-correction term into the dynamic estimations, the forecast performance of the exchange rate was improved.

Empirical evidence of the monetary model of exchange rate as a long-run equilibrium has been fruitful for many industrial countries e.g., the U.S., U.K., Germany, Australia, Norway and Japan as shown by several studies. Turning the perspective to countries with other characteristics, McNown & Wallace (1994) studied whether the monetary exchange rate model could also be useful for countries characterized by high-inflation. They examined Argentina, Chile and Israel for their study because these countries experienced high growth in money and large changes in the nominal exchange rate compared to other industrial countries. By using a variety of model specifications, based on different definitions of money, the opportunity cost and restrictions on model coefficients, they found support for cointegration across all specifications of the model in all three countries. In addition, the authors emphasize that even though the long-run relationships are found, the estimated parameter values and signs are sensitive to model specifications.

Positive results given by the studies of the advanced countries stress the usefulness of the monetary model to exchange rate determination and thus more studies have been conducted and extended to other countries including the Philippines, Malaysia, new EU countries, Turkey, and Nigeria, among many others. In Chin et al. (2007) for example, they adopt the vector error-correction model to study the exchange rate for the Philippines between 1980 to 2003. They find a statistically significant cointegrating vector between the exchange rate and the monetary variables but the speed of the adjustment of the cointegrating vector is quite low with a value of -0.06. The generated dynamic forecasts of the exchange rate provide a good fit to the actual data over the forecast period. Another empirical study was conducted by Baharumshah et al. (2009) for Malaysia using a data set from 1971 to 2006. They found evidence that there is a long-run equilibrium between the exchange rate (MYR/USD) and the macroeconomic factors. They concluded that the monetary model outperforms the random walk for horizons less than 2 years, which provides evidence that the MYR/USD exchange rate is driven by fundamental forces as explained by the monetary model exchange rate framework.

For new EU members and Turkey, Uz & Ketenci (2010) found evidence supporting the long-run equilibrium relationship between the exchange rate and monetary variables. However, they also found that the coefficients for the monetary variables were not consistent with the theory. Given the forecast results, the error-correction monetary model outperforms the random walk and has a tendency to improve over longer horizons. A recent study for Nigeria by Adawo & Effiong (2013), has shown that there is evidence of a long-run relationship between the exchange rate and money supply, output and interest rate differentials for Nigeria. However, they only found statistically significant cointegrating coefficients consistent with the theory for money supply and interest rate differentials but not for the output differential. For the results given, the authors argue that the exchange rate in Nigeria depends on monetary fundamentals.

The improvement of the estimation technique to include the long-run equilibrium has provided evidence that the monetary framework for explaining the exchange rate could be useful in explaining the long-run variation. However, this long-run cointegration test technique is still unable to provide evidence that is consistent with the theory across different model specifications, countries and samples. For example, Uz & Ketenci (2010) found that *not all* of the long-run coefficients of the monetary variables are consistent with the theory even though they are significant. This suggests that perhaps, the long-run equilibrium of the exchange rate is more comprehensive and complex then can be described by the simple monetary model. Cheung, Chinn, & Pascual (2005) found differences in their results for the countries they investigated. This suggests that the models may work for specific currencies and for the specific time period adopted for investigation. Therefore, much care should be taken when considering empirical studies.

3. The empirical model

The monetary approach to determine the nominal exchange rate between two countries is mainly built on three equations, two of which are the demand functions for domestic and foreign economies represented by equation (1) and (2), and the third is the purchasing power parity represented by equation (3) that links the exchange rate with the price levels as shown below.

(1) $m - p = y - i$

(2) $m^* - p^* = y^* - i^*$

(3) $s = p - p^*$

In equations (1) and (2), m is the logarithm of the nominal money supply, p is the logarithm of the price level, y is the logarithm of the real output, and i is the interest rate. An asterisk denotes variables of the foreign country. In equation (3), s is the logarithm of the nominal exchange rate expressed in the number of local currency per one unit of foreign currency. Combining these three equations via purchasing power parity yields equation (4).

(4) $s = (m - m^*) - (y - y^*) - (i - i^*)$

Equation (4) is a monetary model for exchange rate determination that is testable. The model is similar to the one adopted by McNown & Wallace (1994). It is important to keep in mind that the economic environments in Laos and the U.S. are different in many respects. In particular, the financial structure of the U.S. is markedly different from that of Laos. For example, while in the U.S. the opportunity cost of holding money is a discriminating factor for savings and investment; it is not for the case of Laos. Laos is a low-income country where the majority of the people have little, if any, discretionary income that could be directed into savings. Given such a situation, interest rate changes will have little effect on the demand for money. If this assumption holds, it is possible that the inclusion of the interest rate differential in the model will not be very helpful especially in the long-run equilibrium.

4. Econometric approach and results

The data used in this study is retrieved from Allthatstats.com with the original data being sourced from the International Monetary Fund (IMF). The period used for the study is from October 1999 to December 2012. Before 1997, the Lao Kip was pegged to the U.S. dollar, then after the Asian financial crisis in 1997, the Bank of the Lao PDR (BoL) let the exchange rate float due to pressure on the exchange rate itself. Currently the exchange rate appears to be under a managed float regime. Ideally, the sample size should start on the date when the exchange rate floated. Inclusion of the crisis period would introduce external temporary shocks and would make it harder for the

model to disentangle the fundamentals that drive the exchange rate, which is the main purpose of this study. Therefore, it was decided to start the sample data at a time when the crisis had dissipated. However, deciding on the ending date of the crisis is subjective, as it differs from country to country that experienced the crisis. The most relevant country that matters for Laos is Thailand. Thailand's economic growth recovered to positive growth in the last quarter of 1998. In 1999, its GDP growth reached 4 percent (IMF 2000) and almost 5 percent in 2000 according to the World Bank database. With such a positive recovery, the Thai authorities did not draw down from the IMF's stand-by arrangement facility after September 1999. This is a reasonably date that marks the end of the crisis given that the crisis started in Thailand.

The variables used in the study are: s, (m – m*), (y – y*), and (i – i*). s is the log of nominal exchange rate, which is calculated in quantity notation, i.e. units of local currency for one unit of U.S dollar, (m – m*) is the money supply differential represented as the log of money supply in Laos expressed in billions of U.S. dollars minus the log of money supply in billions of U.S. dollars in the U.S., (y – y*) is the real output differential represented by the log of real GDP in Laos expressed in billion of U.S. dollars minus the log of real GDP in billion of U.S. dollars in the U.S. and lastly, (i – i*) is the interest rate differential represented as the nominal interest rate in Laos minus the nominal interest rate in the U.S. The nominal interest rate in Laos is represented by the Kip discount rate, which is the short-term interest rate of Bank of the Lao PDR (BoL). This is the rate at which the BoL lends to commercial banks with insufficient liquidity. The nominal interest rate in the U.S. is represented by the Federal Funds rate.

While only annual GDP is available, the monthly real GDP used in this study is generated using an estimation model based on the application of the theory of best linear unbiased estimation in Chow & Lin (1971). In the first step, using the available annual data, several regression models where GDP is regressed on import and export are compared. Based on model selection using information criteria, the best estimation model that we found for Laos was $GDP = \alpha + \beta 1Export_t + \beta 2Export_{t-1} + \beta 3Import_t + \beta 4Import_{t-1} + \beta 5Import_{t-2} + \varepsilon$. The model is normally distributed, free from autocorrelation and has an R-squared of 0.99. In the second step, the coefficients that are derived from the model are multiplied by import and export data that are derived from equally splitting quarterly GDP into months. From this an estimated monthly GDP is obtained. Next, the estimated annual GDP is compared with the actual GDP; their differences are calculated and divided by 12. These differences are then used to add back to the estimated monthly GDP so that when summing them up, annual estimated GDP is equal to the actual GDP. A similar step is carried out for estimating monthly GDP in the U.S. and the model used to obtain the estimated coefficients is $GDP = \alpha + \beta 1Personal\ consumption\ expenditure_t + \varepsilon$. Lastly, the estimated monthly GDPs are divided by the consumer price index to obtain a real GDP.

Seasonality, Unit Root and Cointegration Test

X-12 ARIMA was used to test for seasonality in s, (m - m*), (y - y*), (i - i*). Only the real output difference was found to have some seasonal dependency and so a seasonal adjustment was applied. Details of the test results are available on request. Following the seasonal adjustment, the Augmented Dickey-Fuller (ADF) test was used to check for stationarity in the variables. The results of the test are shown in table (I) and they suggest that the variables are integrated of order one (I(1)).

Table I. Augmented Dickey-Fuller test

ADF test	**with constant**	**with constant and linear trend**	**without constant or linear trend**
Test at log-level	ADF statistic	ADF statistic	ADF statistic
S	-2.36	-0.57	1.56
(m-m*)	-0.18	-1.95	-1.37
(y-y*)	-1.74	-1.46	0.07
(i-i*)	-0.58	-2.5	-1.35
Test at first difference			
△S	-7.67*	-8.10*	-7.41*
△(m-m*)	-15.51*	-15.54*	-15.40*
△(y-y*)	-4.04*	-4.82*	-3.93*
△(i-i*)	-14.99*	-14.97*	-14.92*

Automatic lag selection base on Schwarz information criterion with maximum lag=13.
Null hypothesis: Variable has a unit root. One asterisk indicates a rejection of the Null at 5 percent significance level.

The Johansen cointegration test was conducted to determine if there is a long-run equilibrium of the I(1) variables ((m - m*), (y - y*) and (i - i*)) for the period 1999M10 to 2012M12. As discussed in Kerry (2000, p623), lag length is a key element in the specification of the VAR, which is usually chosen on the basis that the equation is free from autocorrelation or on one of the information criteria namely: the log likelihood ratio (LR) test, the Akaike information criterion (AIC), the Schwarz information criterion (SC), and the Hanna-Quinn information criterion (HQ). The lag length may also be chosen if it is free from autocorrelation and on one of the information criteria. We adopted a procedure that the lag length will be chosen if it satisfies one of the information criteria and if there is no evidence of serial correlation.

A complication may arise where the lag length as suggested by one of the information criteria is not free from autocorrelation and in such case, the main criteria will be that the equation is free from autocorrelation. We adopted a procedure where we sequentially chose a higher lag structure until there was no autocorrelation. The test started in a VAR framework of the included variables with a maximum lag of 12. Then using the information criteria, each lag system starting from lag 12 down to lag 1 was estimated and compared. According to the information criteria test, potential lag

lengths were identified and then the cointegration test applied. Further references on cointegration can be found in Engle & Granger (1987) and Johansen (1988, 1991) among others.

Following the steps explained above, the lag selection resulted in to two possible lags, which are: 7 according to the AIC, and 2 according to the SIC and HQ. The additional requirement for lag selection was that the residuals should be free of autocorrelation. None of these lags satisfied this requirement. We then proceeded to sequentially choose higher order lags to find if there were any lags that would meet the twin requirements. We found that lag 12 is free from autocorrelation and satisfied the information criterion.

The cointegration test was then applied and suggested that there is one cointegrating vector according to the maximum eigenvalue test and three cointegrating vectors according to the trace test. Details of the test are shown in table (II). According to Lüutkepohl, Saikonen and Trenkler (2001) on the study of maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process, they find that the local power of corresponding maximum eigenvalue and trace tests is very similar. Ideally, both tests should provide the same results, but given that our sample size is small, this may be a factor that contributes to the differences in both tests. One additional important criterion for identifying the cointegrating vector(s) is the stability of the vector(s). This is discussed below.

Table II. Estimating and testing cointegrating vectors

Lag length: 12

H_0	Eigenvalue	LR(r, r+1)	LR(r, N)
r = 1	0.16	27.14*	55.56*
r ≥ 1	0.09	14.23	28.43*
r ≥ 2	0.08	12.42*	14.20*

LR(r, r+1) is the test statistics for the maximum eigenvalue test, and the LR(r, N) for the trace test. One asterisk indicates a rejection of the Null at the 5 percent significance level. The critical values are based on MacKinnon-Haug-Michelis (1999).

As mentioned earlier, the real output difference had seasonal dependency and so a seasonal adjustment was applied. However, seasonality filtering may distort the time-series properties of the series, so it may be preferable to use dummies in the analysis. We examined this by adding dummies into the analysis. The results of the cointegration test did not change so in this analysis the seasonal adjusted series for the real output differential was preferred.

Stability of the vectors is an important aspect to consider for the long-run equilibrium because without stability of the vectors, the system is unlikely to yield efficient estimates. Figure (1) depicts the three cointegrating vectors as suggested by the trace test. It appears that the vectors

are not stable. Figure (2) depicts the one cointegrating vector as suggested by the maximum eigenvalue test. The vector is reasonably stable. In the case of three cointegrating relations, we find that the long-run relations are not stable and thus it is not meaningful to further interpret the results given that the results should be on the basis of stable long-run equilibrium. On examining the one cointegrating vector as suggested by the maximum eigenvalue test, we found that this vector is stable and the long-run relation standardized with respect to exchange rate can be represented as $s_t = -0.00(m_t - m_t^*) - 1.17(y_t - y_t^*) - 0.04(i - i^*)$. It was found that the long-run elasticity of the exchange rate with respect to the money supply difference was insignificant and exhibits the wrong sign. This is supported by the restriction test in table (III), which shows that at a 5 percent significance level we can accept that the money supply difference is not significantly different from zero. On the other hand, the elasticity of the exchange rate with respect to the real output difference is roughly 1 and it is significant. In other words, an increase in the real output difference by 1 percent leads to an appreciation of the exchange rate by 1 percent as well. Lastly, the long-run coefficient of the interest rate difference is found to be significant and we can accept that at a 5 percent significance level it is significantly different from zero. However, given that its coefficient is very small or close to zero, this suggests that it has a small impact on the exchange rate in the long-run.

Figure 1: Cointegrating graphs

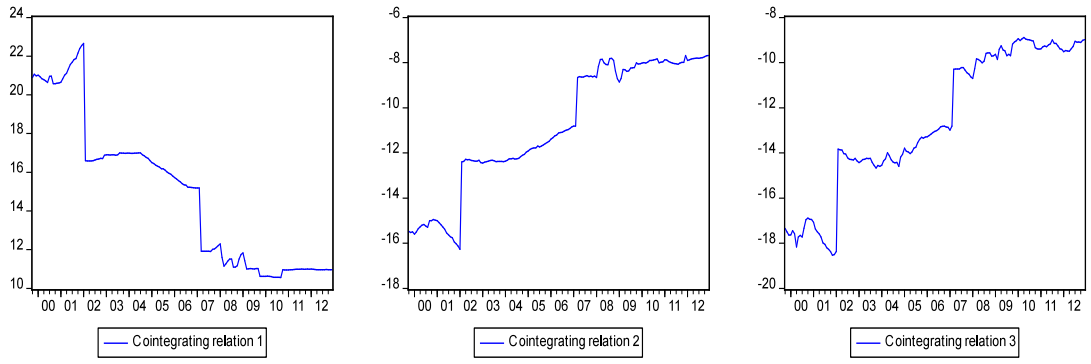

Figure 2: Cointegrating graph

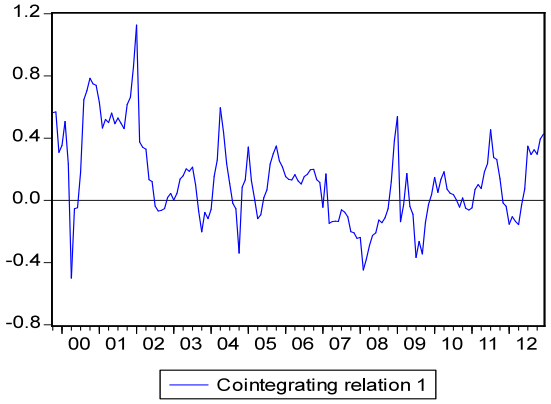

Table III. Testing restriction on the cointegrating vector

LR test for binding restrictions (rank =1)

				LR test of restrictions:		
s	(m-m*)	(y-y*)	(i –i*)	Chi-square	Probability	Result
1	0	Unrestricted	Unrestricted	Chi-square(1)= 0.00	0.99	Accept restriction.
1	Unrestricted	Unrestricted	0	Chi-square(1)= 6.15	0.01	Reject restriction.

Cointegration test (rank:1) with specification: Intercept(no trend) in CE and VAR

In summary, the evidence on the monetary model in Laos is not particularly convincing especially when both the maximum eigenvalue and the trace tests struggle to agree on the number of the cointegrating vector. Furthermore, relying on the result of the trace tests with three cointegrating vectors, these long-run cointegrating vectors appear to be unstable. On examining the one cointegration as suggested by the maximum eigenvalue test, even though the vector appears to be reasonably stable, the parameters of the vector are not consistent with the monetary model, particularly the money supply difference appears to be insignificant.

5. Conclusions

This study sought to answer the question whether the monetary model can be used to explain the Lao Kip/U.S. dollar exchange rate. Based on the results of the cointegration test, the trace test finds three cointegrating vectors of the included series, which appear to be unstable. On the other hand, the maximum eigenvalue test suggests that there exists one cointegrating vector, which appears to be stable. In this long-run equilibrium, the money supply difference is insignificant in explaining the exchange rate. The real output difference is found to be significant and has roughly a one-to-one relation with the exchange rate. In other words, when real output differential increases by 1

percent, we would expect the exchange rate to appreciate by 1 percent. The interest rate difference is significant in explaining the exchange rate and the estimated long-run coefficient is close to zero, suggesting that its impact on the exchange rate is minimal as expected. Based on the results, we find no strong evidence that the monetary model can be used to explain the Lao Kip/U.S. dollar exchange rate.

This provides ground for further research on the topic of exchange rate in Laos. As mentioned at the start of this paper, ideally different models of the exchange rate should be estimated and compared. By doing so, it may be possible to identify those factors that are important in explaining the exchange rate from those that are not. Furthermore, given that this paper looked at a small simple monetary model, it would be interesting to look at a model with additional terms such as the lagged term of the exchange rate as in the study of Woo (1985) and Somanath (1986), the foreign interest rate as in Finn (1986) and dollarization.

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